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The Frequency of Mumps and of Mumps Orchitis and the Consequences for Sexuality and Fertility

BY

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ACTA GENETICA ET STATISTICA MEDICA
Vol. II, 1951. Supplementum I.

THE FREQUENCY OF MUMPS AND OF MUMPS ORCHITIS

AND THE CONSEQUENCES FOR SEXUALITY AND FERTILITY

BY

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BASEL (Switzerland) S. KARGER NEW YORK

Translated by KLAS MAGNUS LINDSKOG

UPPSALA 1951
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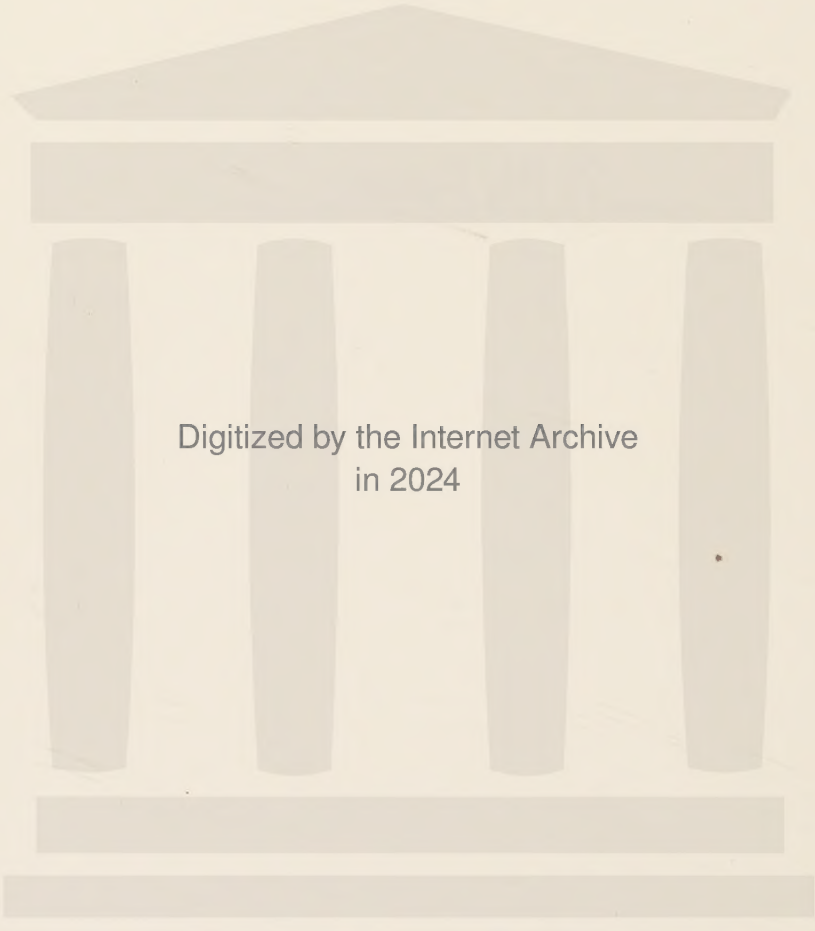
To My Parents



PREFACE

The incidence of mumps happened to be very high in the years 1941–43 at the military establishments where I then was Chief Medical Officer. The outcome of this was that I came to take a special interest in the ailment, not least because it is an important military disease. A matter which I thought required to be looked into rather thoroughly was the extent of the permanent lesions in adult males following mumps orchitis. The present work constitutes an attempt to elucidate and treat this problem by using statistical methods.

The investigation that shortly afterwards was begun—of which this book is a partial result—was supervised with unfailing interest by Professor Gunnar Dahlberg, M. D., LL. D., who liberally gave of his invaluable advice throughout the work. I am most deeply indebted to him for succinct impulses when the work was being planned and for his friendly directions as it was in progress.

Most of the work was carried out at the State Institute of Human Genetics and Race Biology, and I am sincerely grateful to Professor Gunnar Dahlberg, its chief, for freely putting the facilities and staff of the institute at my disposal. It is also a pleasure to have this opportunity of thanking Dr. Christian Hamburger, M. D., for his great interest and valuable advice, as well as for his kindness in letting me have the benefice of doing a number of determinations at the Hormone Department of the State Serum Institute, Copenhagen. I extend my gratitude to Professor Axel Westman for enabling me to do hormone and sperm assays at the Hormone and Sperm Laboratories of the Caroline Hospital, Stockholm. I am particularly anxious to thank Dr. Egon Diczfalusy, M. D., for useful hints and constructive discussions concerning the hormonal part of the work. Most of the sperm studies were performed at the Sperm Laboratory of the Caroline Hospital and it is a pleasure to express my thanks to its chief, Dr. Eric Nordlander, M. D.

The statistical computations were carried out at the State Institute of Human Genetics and Race Biology. Mr. Elvir Lander, Actuary to the institute, gave most valuable aid and good advice

in addition to helping me in many other ways and I am heartily grateful to him for doing so. The staff of the institute are also due my thanks for working on my behalf with interest and application.

Clinical data were made available by a large number of Army Doctors and by the chiefs of Garrison Hospitals, Hospitals for Communicable Diseases, and Laboratories, so I wish to thank all those who thereby have facilitated my work.

The chief of the Medical Administration of the Swedish Defence Forces, Surgeon General David Lindsjö, M. D., and the chief of the Swedish Army Medical Corps, Deputy Surgeon General Sigurd Kihlstedt, have extended valuable aid and made available the archives of the Medical Board of the Defence Forces. I thank them for their great kindness. In particular I wish to thank the chief of the Bureau of Health at the Medical Board of the Defence Forces, Professor Gerhard Rundberg, M. D., for his interest in and friendly advice about my problems.

I beg to thank my superior officer, Major General Sven Colliander, for going to great lengths to facilitate my work.

The investigation was aided economically by a grant from the Medical Research Council.

Uppsala, March 1951.

Bengt Lambert.

REVIEW OF LITERATURE

EPIDEMIOLOGY AND STATISTICS OF MUMPS

Probably owing to the easily recognized symptoms of mumps when it attacks the parotid gland, the organ most commonly involved, the disease has been known since antiquity. Orchitis, one of the not uncommon manifestations of mumps, has also been known for centuries and associated with parotitis. The involvement of the nervous system and pancreas was first described at the end of the nineteenth century. Myocardial damage due to mumps has been described later still. So have other localizations.

As long ago as the end of the eighteenth century it was assumed that mumps was a contagious disease. A series of papers were published in the end of the nineteenth and beginning of the twentieth century in which bacteriologists reported findings of bacteria that they thought gave rise to mumps. Works by Granata 1908, Nicolle & Conseil 1913, Gordon 1914, Wollstein 1916–1918, Johnson & Goodpasture 1934–1936, Findlay & Clark 1934, Levaditi et al. 1935, Rocchi 1941, Enders et al. 1942–1945, and Habel 1945 have made it abundantly clear, however, that the cause of the disorder must be looked for in a specific contagion of viral nature.

Habel 1945, Henle et al. 1948, and others have shown that the virus is present in the saliva of patients with mumps. Using complement fixation and cutaneous reactions, Enders et al. (1945), Enders & Stokes et al. (1946), and Henle et al. (1948 a) demonstrated that mumps may be accompanied by unapparent infections, which previously had been suspected for epidemiologic reasons. Henle et al. (1948 b) successfully isolated virus from patients with unapparent disease who had been infected 15–24 days earlier with mumps virus cultured on chicken embryo. This supported an earlier theory by, for example, Gordon & Heeren (1940) who on the basis of epidemiologic findings had concluded that some unapparent cases could be contagious. Similarly, Henle et al. (1948 b) demonstrated the presence of virus in the saliva of a patient with orchitis and without clinically manifest parotitis.

Since virus infection apparently can occur in the saliva of patients with mumps, irrespective of its clinically demonstrable site, it seems likely that the disease always is propagated by droplet infection. Mumps is often epidemic, but the epidemics are usually prolonged and not nearly so rapid as those of measles and varicellae. According to HABEL (1945) this is because coughing is not a common symptom of mumps, and hence not very many infectious droplets are coughed out into the air. Whenever an infection of the upper respiratory tract is present at the same time, mumps can be propagated far more rapidly than usual. An example of a mumps epidemic that developed very quickly is the one which struck Camp Wheeler (RADIN 1918, SAILER 1919), where within $2\,^1/_2$ months 32 per cent of a force of 18 000 men came down with the disease.

The observations reported in epidemiologic and etiologic studies, which have been reviewed briefly in the above, have led to the currently held view that mumps is a general systemic infection. Some authors (REIMANN 1945, HOLDEN, EAGLES & STEVENS 1946, RAMBAR 1946) have therefore expressed the opinion that the term parotitis epidemica is misleading, partly because mumps virus not always causes parotitis and partly because parotitis not always is primary. These authors reserve the designation parotitis for cases when the parotid gland is involved. They consequently regard symptoms from other organs not as complications to parotitis but as other localizations of mumps.

The propagation of mumps is governed by two factors: 1. the spread of contagion and 2. the frequency of susceptible persons. With respect to the latter factor it would be particularly interesting to know the incidence of the disease in a population that has never been attacked and in which, consequently, acquired immunity cannot obscure the picture.

The steadily improving communications of our day are making more and more uncommon observations from epidemics of infectious diseases in isolated populations which have been free from the disease for a considerable time. Nevertheless, some such epidemics have been described. The factors concerned are best known for measles. PANUM (1847), for example, found that the susceptibility to measles was about 80 per cent in the population of the Faroe Islands, where previously the disease had not occurred.

So far as I have been able to find the author can see only one epidemic of mumps has been described from which information can be

obtained concerning the non-acquired immunity. ROHLEDER (1927) described an epidemic of mumps in a Faroe Island village where the disease had not occurred for 30 years. The village had 390 inhabitants, 210 of whom were below 30. The disease attacked 121 of the latter. The author expressed the opinion that the propagation of mumps requires direct and intimate contact and that therefore only such persons were exposed as lived in houses where cases of mumps had occurred. In 17 houses the disease did not occur, in 14 it attacked all inhabitants below 30, in 19 most of the inhabitants below 30 became ill. The houses where cases of mumps occurred were lived in by 170 persons below 30 years of age. Hence 71.2 per cent of the latter were infected. From this the author drew the conclusion that 28.8 per cent of the population below 30 were immune. Conversely, if all the inhabitants below 30 are considered to have been exposed to the disease, 57.6 per cent were attacked and 42.4 per cent would be immune. This report provides no information concerning the natural susceptibility of those over 30, because there had been mumps in the village 30 years earlier. The low frequency of mumps in persons older than 30 might therefore have been due to acquired immunity.

From the data given it is difficult to draw any definite conclusions. For one cannot estimate the number of persons who remained healthy despite being exposed then and earlier to infection. The conclusion may possibly be drawn that if an epidemic of mumps breaks out in a population that previously has not been exposed to infection and therefore lacks acquired immunity, from one-fourth to one-half of the population in age groups below 30 will be immune to the disease.

The susceptibility above age 30 seems to be less pronounced. It should be kept in mind, however, that epidemics have occurred before and acquired immunity may consequently be the reason for the lesser susceptibility of persons over 30. It would naturally be desirable to obtain data on the frequency of natural immunity in various age groups, but available observations are too few to provide any reliable clues in this respect. With respect to the sex differences in natural immunity, however, a few facts may be gleaned from the available data. Thus, it is remarkable that far fewer men than women fell ill in the age group 20–30 years whereas approximately the same number of boys and of girls fell ill. This observation contradicts the one most often quoted in the literature: that boys and men are more susceptible to mumps than are girls and women. From his observations, ROHLEDER drew the conclusion that men either are less ex-

posed to contacts owing to their extradomestic work or else they must be less susceptible to mumps. It seems equally likely, however, that on trips away from home they previously have been more exposed to contacts and perhaps have acquired immunity through subclinical infections. Unfortunately, though, the series is not large enough to permit of drawing definite conclusions.

Records of expeditions to isolated populations on, for example, the Hawaii Islands (Jarves 1844, Wilkes 1844), New Zealand (Thomson 1855), and Tristan da Cunha (Henriksen & Oeding 1940) mention epidemics of mumps that as a rule have involved a very large part of the population, but numerical data of use for evaluation of the susceptibility are not given.

Mumps has always been more or less widespread, just like other infectious diseases, in communities with well developed communications. Therefore, the population that is exposed to any given epidemic is always to some extent immune. The severity of the epidemic depends on social conditions. For example: it will very likely be more extensive in a dense population than in a sparse. As we know, military conditions and schools usually aggravate the risk of spreading epidemic infectious diseases, mumps included. Mainly to exemplify these considerations, some epidemics will be described in the below.

Rilliet & Lombard (1850, cited from Comby 1893) described an epidemic among the civilians of a town where 73 cases occurred, 7 of which involved children of 3–5 years, 37 the groups 5–15 years, 8 the ages 15–20, and the oldest victim was a person between 60 and 70 years old.

Hanson (1907) found that of 85 Norwegian recruits, who were quartered in 8 barracks, 18 contracted mumps. Gundersen (1934), who has cited this, drew the conclusion that 26 per cent were susceptible (probably inexact; should be 21 per cent). The same encampment contained about the same number of other barracks with an equivalent number of recruits, so it would seem rather unsafe to draw definite conclusions as to the susceptibility in this epidemic. In an epidemic in a Norwegian district with 1255 inhabitants Arnesen (1909) reported that at least 28.8 per cent became ill with mumps. Radin (1918) and Sailer (1919) stated in their reports on an epidemic in Camp Wheeler, Georgia (a semi-densely populated state, according to Love & Davenport, 1919, having the greatest frequency of mumps among U. S. army recruits), that 32 per cent of

the 18 000 troops contracted mumps. Brooks (1918) described an epidemic among American males on military service in Camp Upton, where 1059 cases occurred from Sept. 5 1917 to July 12 1918. 85 per cent of the patients came from rural districts and 15 per cent from cities. He omitted to mention the number of men in each group. According to Selso (1943) an epidemic of mumps among the Copenhagen garrison involved 28.7 per cent of one unit and 7.5 per cent of another. In an epidemic in a private school with 161 pupils aged 3–13 years, 148 of whom had not had mumps before, Levine (1944) found that 66 pupils were attacked. Mac Guinness & Gall (1944) have described an epidemic with 1378 cases of mumps in Camp Mc Coy 22 11 1942 – 23 6 1943. Cases occurred in 188 companies, the highest frequency being 19 per cent of one company on the sick list. The frequency exceeded 10 per cent in only few companies. Urban and rural populations were represented about equally. Among the latter 74.5 per thousand per annum were infected, while the corresponding figure for the other group was 15.4. Evidently these figures are very similar to those reported by Brooks (1918).

According to Leineberg (1945 b) totally 10 215 cases of mumps occurred in all Finnish recruit schools from Oct. 1941 through August 1942. As many as 25–30 per cent of the conscripts were infected in certain schools, e.g. of the first levy of 1000 men at the Cavalry School 277 fell ill. 284 men on the unit had had mumps before (probably the author means that they said they had had mumps). The rest, 716 men, had not had mumps before, and 262 of these contracted uncomplicated parotitis, i.e. 36.6 per cent. Only 15 of those who stated they had had mumps were infected, i.e. 5.3 per cent. Consequently 546 or 54.6 per cent had had or did get mumps.

It is more valuable to get to know the incidence of the disease in a whole population *over a sequence of years*. Then any variations in the spread of the epidemics can be reckoned to level off to a fairly constant figure. One year an epidemic may strike one region and another year some other region. One year the disease may be more common and another year less common. Owing to the wave shape of the epidemic curve that is characteristic of mumps (Sinclair 1922, Gundersen 1934, Lambert 1947), a person in the twenties should have experienced two or three such epidemics. It is possible, however, to obtain figures for the average incidence o the disease in a given region under the social conditions obtaining

in that region. Such figures have been published from, for example, Denmark.

Ringberg (1896) investigated the incidence of mumps in Denmark in the years 1885–1894, finding that the disease occurs at all ages, even in infancy and over 65, but that it is most prevalent in the age group 5–15 years. Since the study embraces a decade and a whole population and, as just stated, the effects of any general or local undulations in the epidemic curve consequently can be safely disregarded, it probably may be accorded some value as an indicator of when the risk of getting mumps is greatest. On the other hand, the reliability of all such studies will be adversely affected by two factors: all cases are not reported, and there is no means of knowing whether the frequency of reported cases is the same in all age groups. Ringberg came to the conclusion that the disease is much more common in children than in adults, which of course was to be expected. He then considered the frequency in adults, finding that mumps is rarer in women than in men. He attributed this to men's military service and to their disposition to go to the doctor when there is anything wrong with them. Women are more patient. In order to reduce the effect of these factors Ringberg made a separate study of towns without garrisons and with an adequate number of physicians. He then found a difference in the frequency of the disease. In men the frequency was 0.73 ± 0.045 ‰ and in women it was 0.64 ± 0.040 ‰, that is, the difference was 0.09 ± 0.06 ‰. However, from a statistical point of view the difference was not significant because of the limited number of cases.

Investigations like the one just mentioned to some extent provide an approximate, undifferentiated picture. One needs to know how often the disease occurs in different age groups. However, figures for age groups will be more unreliable than figures for a whole population, and, moreover, they vary according to the type of persons studied. Nevertheless, a few investigations of value in this connection do exist. Rilliet & Lombard (1850) found, as already mentioned, that the majority of cases occur in the age group 5–15 years. Manine (1913) stated that in mumps epidemics on two cruisers 80 per cent of the cases occurred among men aged 18–25. The information is of scant value, however, because the author did not give the age distribution of the crews. Bardachzi & Barabas (1920) said that in an epidemic among soldiers 45.6 per cent of the cases occurred in soldiers less than 20 years old, whereas only 4.3 per cent of the

Table 1. Susceptible Children and Children who Developed Mumps at Different Ages (after LEVINE).

Age in years	Susceptible children	Developed mumps
3	12	2
4	11	1
5	11	1
6	14	7
7	17	10
8	16	8
9	15	9
10	11	6
11	14	9
12	15	9
13	12	4
Total	148	66

patients were older than 40. Nor here was the necessary age distribution given. MEYER & REIFENBERG (1926) have reported on 136 hospital cases from 1909–1925, the youngest patients being in their first year and the oldest one between 40 and 45. More than half the cases (72 out of 136) occurred between 2 and 7 years. Only 15 patients were between 15 and 25 years old. The series is probably too small, however, to allow of any definite conclusions. As mentioned in the foregoing, LEVINE (1944) described an epidemic of mumps in a private school. During the 12 years immediately preceding the epidemic the school had been practically without mumps. The number of susceptible children and the number of those who did get mumps in different ages are shown in table 1. It reveals that approximately half (44.6 per cent) of the susceptible children were infected. HAEREM (1945) asserted that most of the 1470 cases at Port Sill in the period 1941–1943 occurred among young men in the 19–25 year group. HEIBERG & PETERSEN (1945, 1946) reported that 75 per cent of the 13 106 known cases of mumps during 43 weeks of the Copenhagen epidemic 1941–1942 occurred in the age classes 1–15 years. To some extent, however, this series may be selected, because cases among school children probably were reported oftener than those among any other group save military personnel.

COLLINS (1924) during $1\,^1/_2$ school years studied the morbidity among school children in an American city with 28 000 inhabitants

(the Hagerstown study). He observed 1.2 cases of mumps per 1000 school children per school year of 180 days, while for all other diseases combined the corresponding figure was 2333.1, e.g. for measles 52.8. Such a study, embracing only a special population group and a single year, is necessarily of limited value: the result must be greatly dependent on whether or not an infectious disease occurred epidemically during that year. As a matter of fact a slight influenza epidemie accurred in the population that year.

It would lastly be possible to combine the various age risks and ask what chances a person has of getting the disease when he has lived through these ages. One computes, in other words, what statistically is known as the cumulative risk. A direct approximation of the value for this risk may naturally be obtained by finding out how many persons have had the disease at different age limits. Many studies have been devoted to these matters.

Collins (1929), using different populations, found at each age level the percentage of persons with a history of mumps. The series comprised school children at 15 different places, undergraduates at 11 universities, children, the majority in school age, in an American town, and individuals up to 20 years old in a Canadian town. At an age of 4.5 years 9.08 per cent had had mumps, at 6.3 years 19.91 per cent, at 15.1 years 59.33 per cent, and at 19.5 years 62.94 per cent. It may be mentioned by way of comparison that the corresponding figures for measles and diphtheria at age 19.5 years were about 89 and 10 per cent. Graphically, Collins also demonstrated that the maximum frequency of measles, whooping cough, chicken pox and diphtheria occurred at age 3–4, of scarlet fever at age 5–6, and of mumps considerably later, i.e. at age 7–8.

The same author (1933, 1935) compiled results of medical examinations performed at intervals of 2–4 months during one year on about 9 000 families with almost 40 000 members. The examinees were domiciled at 130 different locations in 18 American states. That year mumps averaged 12.1 cases per 1000 examinees. Table 2 reveals the age distribution of the mumps patients.

Collins' studies seem to show that in the U. S. the risk of getting mumps is largest between 5 and 15 years, and that at least 60 per cent of 20 year olds have had mumps. With respect to the age distribution it should be noted, however, that compulsory military service had not been introduced in the U. S. at the time of the survey and that hence the majority of the male population in the series

Table 2. Age Distribution of a Series of Mumps Cases (after Collins).

Age in years	Cases of mumps in per mille of individuals of corresponding age
0— 4	14.7
5— 9	33.8
10—14	22.3
15—19	9.5
20—24	2.4
25—34	4.4
35—44	3.4
45—54	1.5
55—64	1.4
65—ω	0

Table 3. Age when Mumps Developed, According to Case Histories (after Candel, Wheelock & Grimaldi).

Age in years	Cases of mumps	Per cent of total cases of mumps	Per cent of all individuals investigated
1— 4	84	7.5	3.5
5— 9	470	41.8	19.8
10—14	381	34.0	16.1
15—19	145	12.9	6.1
20—24	32	2.9	1.4
25—29	7	0.6	0.3
30—34	2	0.2	0.1
35—39	1	0.1	0.05
Total	1 122	100.0	

had not been exposed to the augmented risk of getting mumps that apparently goes along with barrack room life.

Candel, Wheelock & Grimaldi (1945) followed up the problem by asking 2368 draftees whether and if so at what age they had had mumps. The men were all between 17 and 38 years old, and 1122, i.e. 47.3 per cent said they had had mumps. The age distribution appears in table 3.

Evidently the figures for the incidence of mumps up to age 20 are much lower, as reported by Candel et al., than might be expected from Collins' figures. The latter series, however, might have been partially selected, as the investigation seems largely to have embraced densely populated areas.

Figures from a series of conscripts can be used to evaluate the frequency of mumps and the risk of getting it during the period of military service. If the study is confined to an isolated population (e.g. a single unit or a training camp) and to a single year, the result will of course have only limited value. If, on the other hand, many military populations are studied at one time or if one population is followed for several years, the resultant figures will be more generally applicable, although not exact.

Yet another factor considerably affects the frequency of mumps in a military population, viz. the method of recruitment. In an enlisted army, the members of which have signed up for several years, the frequency is small because the successive recruitment prevents undue accumulation of susceptibles. In conscripted armies, on the other hand, a greater or smaller number of susceptibles are annually brought together. Such accumulations become even more marked in countries without a standing army in peacetime, but where large numbers of the male population are called to the colours in a national emergency. Data on mumps in the American Army are given in table 4.

Sinclair (1922) showed that the frequency of mumps in the American Army rose sharply, compared to the number of soldiers, at the time of the Civil War and of the 1st World War. The incidence of mumps was much greater among soldiers from rural parts than among cityfolk. He emphasized that civilian statisticians, owing to their imperfect reports, especially as regards adults, tend to give a fallacious picture of the age distribution. He pointed out also that although military figures provide no age classification they do demonstrate a considerable susceptibility in adults, all the more so as military statistics in time of war are higher than those ever seen in child populations. No age goes free but as an attack is followed by relative immunity the proportion of susceptibles decreases with increasing age.

Love & Davenport (1919) studied the susceptibility to six different infectious diseases, among them mumps, in American recruits and compared the figures for recruits from densely and sparsely populated areas. They observed fair agreement between the density of the population in the recruitment area and reduced susceptibility.

Wesselhoeft (1942) stated—without supplying detail data on his series—that 90 per cent of any city population over 15 have gone through an attack of mumps, whereas the percentage for sparsely

Table 4. Data on Mumps in U. S. Army during World War I and II.

Data	The whole army during World War I		A. E. F. 1/7 1917—30/4 1919	The whole army during World War II[2]	
	after		after	of which	
	Sinclair	Mitchie[1]	Emerson	in U. S.	overseas
Cases of mumps	231 490	230 356	81 899	85 733	19 133
				104 866	
Cases per 1 000 men	—	55.8	—	—	
Deaths	—	—	43	—	
Death rate in per cent	—	—	0.05	—	
Declared unfit because of mumps	—	50	—	—	
Service days lost	—	3 884 147	1 021 636	—	
Mean service time (days) lost because of mumps	16.8	—	—	—	
Service days lost because of mumps in per cent of days lost in all diseases	6.3	—	—	—	
Non-effective ratio per 1 000 men	—	2.5	—	—	

populated rural districts are much lower. He expressed the opinion that metropolitan areas are reservoirs of virus which is kept alive by clinical and subclinical attacks and perhaps by virus carriers.

According to Mac Guinness & Gall (1944), an epidemic with 1378 cases of mumps among soldiers, about half of whom came from the country and half from cities, showed a frequency of 74.5 per thousand among the former and of 15.4 per thousand among the latter.

Some authors (Ringberg, Rohleder) have, as mentioned previously, studied the *sex proportion* among cases of mumps. Cases that occur during military service can obviously only attack men and, if included, such cases distort the proportion. Consequently, the sex proportion can only be studied by either observing an isolated population in which the disease has not occurred in the lifetime of the living generation, or by confining the investigation to younger age groups. A few such investigations are available. Ringberg came,

[1] Med. Dept. of U. S. army.

[2] The data were obtained through Professor G. Rundberg from the General Surgeon Blitz, to both of whom I extend my deep gratitude.

as mentioned, for good reasons to the result that there is no difference in disposition between the sexes. Rather a remarkable series has been accounted for by MEYER & REIFENBERG (1926). They found that of 112 children with mumps 69 were boys and 43 girls, while the adult patients comprised 5 men and 19 women. There were 10 cases in the first year of life, 8 of which attacked boys. With regard to the adults, 13 of the women were nurses or women who had been taking care of patients with mumps. The authors maintained that a sex difference in susceptibility exists, men being more susceptible to mumps than women. The authors admitted, however, that men usually are more exposed to infection due to cramped quarters in ships, barracks, etc. Although the series was specially selected and far too small to permit of drawing definite conclusions, it more than anything else speaks against a sex-conditioned difference in susceptibility, since women evidently succumb to the disease quite often, when they are as much exposed to infection as men are in barracks where the disease occurs.

GUNDERSEN (1934) stated that of the 1627 reported cases of mumps at Oslo in the decade 1912–1921 59.8 per cent occurred in men and 40.2 per cent in women. Below age 15 the corresponding figures were 52.7 and 47.3 per cent. Above age 15 they were respectively 67.8 and 32.2 per cent. It will be seen that the difference below age 15 is not significant. From the difference above the age limit of 15 years the author drew the conclusion that sexual maturity seemed to have increased the men's disposition to mumps. However, the reasoning RINGBERG applied to his results would seem to be valid in this instance also.

RILLIET & LOMBARD (1850, cited from COMBY 1893) observed that totally 38 men and 35 women were infected among the civilian population in an epidemic that took place in a city. More than half (52) the patients were younger than 20 years. BROOKS (1918) reported on an epidemic in a training camp where 1059 soldiers contracted mumps. He noticed that only 3 out of 300 nurses, whose age distribution was similar to that of the men, became ill. He considered mumps to be a "male disease."

A problem of particular significance for the present investigation is whether persons can get parotitis several times or, in other and more precise terms, to what extent do persons who have had an attack of mumps become immune and is this *immunity* lasting. The literature contains some relevant data.

Comby (1893) held that relapses in mumps do not occur or are very infrequent. He cited Rilliet who had given examples of permanent immunity. He characterized as an exception a case described by Servier which concerned a soldier who fell ill with mumps despite 5 years ago having had mumps with orchitis and resultant testicular atrophy.

Nimier (1883) interested himself particularly in this problem and reviewed the data published up to then on relapse in mumps. He commented that authors who had written about mumps had been eloquently silent on the subject of relapse, and he therefore drew the conclusion that relapses are rare. He stated also that Laveran, in a detailed paper on mumps, expressed the opinion that immunity is the rule after an attack of mumps and that in consequence relapses are rare. As examples of the rareness of relapses he cited Servier (1878), who found 1 relapse among 105 patients, and Marty, who reported one relapse in an epidemic with about 100 cases. He maintained, moreover, that the number of relapses are exaggerated in some statistics, giving as an example Fournier (1881), who found 5 relapses in 24 cases. Nimier described from his own experience 5 cases of relapse, one of the patients having had mumps not less than 4 times. All these cases have concerned soldiers.

Radin (1918) reported 47 out of 5756 cases with a history of mumps, i.e. about 0.8 per cent. Feiling (1915) held that it is extremely difficult to find incontrovertible cases of relapse and thought that an attack of mumps as a rule is followed by lifelong immunity. Gordon & Heeren (1940) considered that relapses are "not very common."

Moutier (1922) found 9 cases of relapse among 600 soldiers with mumps. He took into account only such cases as he had seen himself on both occasions. Since the 600 soldiers in the series were treated at a hospital in one year, Moutier's findings are naturally of value only for relapses coming at intervals shorter than one year. The author distinguished between relapse and recrudescence, the latter denoting cases without completely regained health between the attacks. An interval of 2–3 months had at least gone by between the attacks in the relapsed cases. Moutier's results are valuable because he imposed such stringent conditions for acceptance of true relapse. On the other hand, no conclusions can naturally be drawn concerning the frequency of relapses during conscript age or after an attack of mumps during childhood. Moutier also reviewed studies

by Catrin, who reported 6 cases of relapse in 100 cases of mumps, and Dopter, who held that relapses were fairly common.

Green & Heeren (1937–38) claimed that relapses had occurred in 4 per cent of 100 hospitalized soldiers, one of them having had mumps more than twice.

Leineberg (1945) described an epidemic in a unit of 1000 troops, 284 of whom claimed to have had mumps, with 277 cases of mumps, i.e. a frequency of 27.7 per cent. Out of the 284 who claimed to have had mumps 5.3 per cent became ill and 46.4 per cent of these got orchitis. He also described another epidemic in a unit of 516 soldiers of whom 23.5 per cent said they had had mumps previously. Of these latter 8 per cent were reinfected, none with orchitis. Both epidemics occurred among men in their twenties.

Laurence & McGavin (1948) stated that out of 235 persons who fell ill during an epidemic described by them 18 claimed that they had had mumps previously while 6 thought they had had the illness though they were not sure.

With aid of the fixation of the complement reaction, investigations have been performed in order to demonstrate the presence of antibodies. Using this method, Enders (1943) found that 50 per cent of those who denied having had mumps had serum containing antibodies.

FREQUENCY OF ORCHITIS

It has been known for ages that in adult males orchitis may be a manifestation of mumps. Orchitis occurs as a rule only during and after puberty, and the literature contains only few case reports before that age. It would seem, in other words, as though mumps virus does not readily attack infantile testes. Since a large number of cases of mumps in adult men occur among men on military service, orchitis has been accorded particular attention in military epidemics.

The frequency of orchitis in an epidemic of mumps has been variously estimated by different authors. According to Comby (1893) descriptions exist of epidemics among French military personnel, in which all cases of mumps were complicated by orchitis (Saucerotte, Noble, both cited from Comby, 1893). Such a high frequency of orchitis must evidently be inaccurate. It seems likely that only cases of mumps with orchitis were given treatment. Epidemics have been described with merely 1–5 per cent of the mumps cases being

associated with orchitis (Luehe 1879, de Massary & Tockmann 1916). It even seems as though the frequency of orchitis is capable of varying greatly under very similar conditions. Thus, in an epidemic in April and May 1915 with about the same number of cases during each month, de Massary & Tockmann (1916) found 27 per cent orchitis in April but only 5 per cent in May. The variable orchitis frequency might have been due to altered viral virulence but it is possible also that the persons infected during the first month were particularly susceptible and that those infected later were less susceptible and less often got orchitis.

Compilations of data from older literature have been published by Wesselhoeft (1920) and Stengel (1936). They give the impression, in conjunction with data from Comby (1893), that the frequency of orchitis often is higher in epidemics with fewer manifest cases. This may be due to closer observation of the patients in lesser epidemics, but it may also have to do with the proportion of known cases. When only a few cases become known, a high frequency of orchitis can be expected. Patients with orchitis almost always call a physician. From military populations, in which the cases are registered more or less independently of severity, the most reliable frequency figures should be obtainable.

In table 5 I have collected data culled from papers, particularly newer ones, which have been available either as originals or, exceptionally, in cited form. It is rather difficult properly to tabulate such data, since the information often is incomplete and the series of patients in part selected. The data contained in the table must therefore necessarily be commented on rather fully. It will be seen that some authors have omitted to specify the number of patients or given percentages instead of absolute numbers of orchitis cases. In addition to the figures entered in the table, Ramond & Goubert (1915) stated that, of their 115 patients, 20 had epididymitis, 40 funiculitis and 23 prostatitis, which figures are very high for these localizations and lack counterparts in any other studies. Also Weigert (1915) reported a case of funiculitis.

The same author has several times accounted for a number of different series. Weigert had both a series consisting of hospitalized patients from troop units and a series of patients from a field unit, which latter series he merely mentioned in passing and apparently had not treated himself. Capitan (1918) published statistics from the French army for 316 cases during 1914–1916, 189 cases in 1917

Table 5. Frequency of Orchitis.

Author	Year	Cases of parotitis epidemica = N	Orchitis		Bilateral orchitis		
			No.	in per cent of N	No.	in per cent of the whole no. of orchitis	in per cent of N
Granier	1879	57	8	14.0	2	25	3.5
Calmette	1883	55	10	18.2	1	10	1.8
Martin	1894	48	9	18.8	2	22	4.2
Ringberg	1896	1 100	279	25.4	33	11.8	3.0
Manine	1913	143	13	9.1	2	15	1.4
Ramond & Goubert	1915	115	5	4.3	3	60	2.6
Weigert	1915	39	11	28.2	—	—	—
		40	1	2.5	—	—	—
Clement ref. Wesselhoeft	1917—18	443	122	27.5	—	—	—
Brooks	1918	1 059	—	24	—	95	—
Capitan	1918	316	50	15.8	—	—	—
		189	28	14.8	—	—	—
		195	49	25.1	—	—	—
Radin	1918	4 397	611	13.9	102	16.7	2.3
Macleod	1919	693	140	20.2	—	16	—
Bardachzi & Barabas	1920	—	—	10.8	—	—	—
Moutier	1922	600	68	11.3	—	—	—
Sinclair	1922	221 060	24 330	11.0	—	—	—
Odenius	1925	57	7	12.3	—	—	—
		46	6	13.0	—	—	—
	1926	53	5	9.4	—	—	—
Iversen	1930	76	24	31.6	3	12.5	3.9
		56	16	28.6	3	18.8	5.4
		56	11	19.6	1	9	1.8
		—	15	—	6	40	—
Sylvest	1932	37	13	35.1	4	31	10.8
Janbon, Alquie & Simon	1937	83	18	21.7	—	—	—
Green & Heeren	1937—38	—	—	43	—	—	—
Bang & Bang	1943	74	49	66.2	—	—	—
Curtz	1943	22	8	36.4	—	—	—
Macguinness & Gall	1944	1 364	494	36.2	53	10.7	3.9
		250	—	about 15	—	—	—
		300	—	» 15	—	—	—
		700		24	—	—	—
Selsø	1943	89	33	37.1	—	—	—
		124	45	36.3	—	—	—
		50	15	30.0	—	—	—
		—	54		7	13.0	—
Haerem	1945	1 470	—	24	—	7	—

Table 5 (cont.)

Author	Year	Cases of parotitis epidemica = N	Orchitis		Bilateral orchitis		
			No.	in per cent of N	No.	in per cent of the whole no. of orchitis	in per cent of N
Leineberg	1945	677	—	34.5	—	—	—
		277	99	35.7	—	—	—
Löfgren ref. Leineberg	1945	518	—	24.3	—	—	—
Nixon & Lewis	1945	339	101	29.8			
Humphries	1947	132	38	28.8	6	15.8	4.5
Hanssen	1948	—	74	—	7	9.5	—
Lambert	1948	1 411	299	21.2	30	10.0	2.1
		125	30	24.0	6	20.0	4.8
		328	56	17.1	3	5.4	0.9
Laurence & McGavin	1948	203	53	26.1	5	9.4	2.5

and in 1918 up to August 31st for 195 cases. All the 700 patients were treated at a hospital for epidemic diseases. Odenius (1925, 1926) obtained his results from a series of conscripts in the Swedish army. The 46 cases, 13 per cent of them with orchitis, included such treated with convalescence serum. Iversen's (1930) series comprised patients treated at the Danish army hospital for epidemic diseases, the first 76 of whom being patients that were hospitalized before convalescence serum treatment was introduced. The figures on the next line refer to the 56 patients in the control group and those on the line after that to the group of 56 patients who were treated with convalescence serum. The figures below the line just mentioned refer to 15 patients who were admitted for orchitis, i.e. in them the disease was first manifested as orchitis. The series published by Selsø (1943) consisted of conscripts from 3 different troop units during the Danish epidemic 1941–1942, but Selsø reported 7 cases of bilateral orchitis out of 54 cases of orchitis without explaining why the figure does not agree with the figure for the whole series. Mac Guinness & Gall (1944) published statistics from various camp stations of the U. S. Army. Leineberg (1945) described a series of 677 patients in a Finnish military hospital, 78.5 per cent of whom were conscripts aged 18–20. The 277 cases occurred among conscripted recruits. In a later publication he stated that this series comprised 300 persons, 122 of whom were hospitalized immediately after observation of the first symptoms and who showed a frequency

of orchitis of 36 per cent, while 178 were admitted to hospital on the second day of illness and had an orchitis frequency of 29 per cent. He described, moreover, an additional series—not entered in the table—of 220 cases, 110 of which with an orchitis frequency of 18.2 per cent were treated with potassium bromide, while an equally numerous control group showed a frequency of 32.7 per cent. Lastly, with respect to my own series (LAMBERT, 1948). it consisted both of 1411 conscripts treated at different regimental hospitals in the Swedish army during the period 1919–1926, of conscripts treated at two regimental hospitals in 1942 and of 125 patients who had been under my supervision at three different hospitals 1943–1944.

It will be seen that the frequency of orchitis ranges between 66 per cent (BANG & BANG 1943) and 2–5 per cent (RAMOND & GOUBERT 1915, WEIGERT 1915) of the mumps cases. Let it be remembered, however, that BANG's statistics came from a hospital for epidemic diseases, where the frequency of orchitis naturally would be higher than in the population as a whole. The 74 patients entered in the table were males aged 13 and up, and during the epidemic altogether 361 patients were hospitalized. These very figures afford an admirable opportunity of estimating the difference resulting herefrom. For SELSO's results came from the same epidemic (Copenhagen 1941–1942), but applied to conscripts all of whom with mumps were admitted to regimental hospitals. The latter frequency values must surely much more adequately portray the frequency in the 20–30 year olds than the former frequency in the male population over 13. Series with a fairly small number of cases provide unreliable statistics because just a few cases of orchitis can greatly influence the percentages. To draw the line is difficult, however, but series comprising less than 100, and above all less than 50, cases should surely be regarded rather cautiously. Statistics like SINCLAIR's, for example, which were based on the very large number of cases reported in the U. S. Army during the first World War, are also unreliable, because of the uncertainty of the recorded special localizations of mumps and the imperfect reporting system. The same applies to the 1411 cases recorded by the writer (LAMBERT, 1948). Since my own study concerns the frequency of orchitis in conscripts, particularly in those aged 20 or thereabout, series of cases in 20–30 year olds are the most valuable, particularly if they occurred while on military service (CAPITAN, RADIN, MACLEOD,

Moutier, Mac Guinness & Gall, Selsø, Haerem, Nixon & Lewis, Leineberg, Humphries, Lambert, Laurence & McGavin). In these authors' reports the frequency of orchitis in the course of mumps ranged between 11.3 and 37 per cent. Nine of these 12 authors gave frequencies between 20 and 30 per cent. It is difficult, however, to estimate the extent to which patients are admitted to hospital only because of parotitis. On the other hand, it may be assumed that persons with orchitis always get hospital treatment. Therefore it may be that the figures for orchitis tend to be slightly on the high side.

Seventeen of the authors included in the table have given the number and or percentage of cases of *bilateral orchitis*. If series so small that a single case can considerably influence the percentage are disregarded on this occasion also, only few series remain such that information can be obtained as to the frequency of bilateral orchitis in relation to the cases of orchitis and to all cases of mumps (Radin, Macleod, Selsø, Haerem, Humphries, Lambert, Laurence, & Mac Gavin). The frequency values given by these authors vary between 16.7 (Radin) and 7 (Haerem) per cent of the orchitis cases. Only three of the papers mentioned specify or give data permitting the calculation of bilateral orchitis as a percentage of all cases of mumps (Radin: 2.3 %; Humphries: 4.5 %; Laurence & Mac Gavin: 2.5 %). In my own study, published 1948, the frequency varied between 5.4 and 20 per cent of the orchitis cases and 0.9 to 4.8 per cent of all cases of mumps.

Without giving his sources, Seguy (1942) has in a survey on mumps orchitis stated that mumps in adults is associated with orchitis in 20 and with bilateral orchitis in 7 per cent of the cases.

It may be said, by way of summing up, that according to data in the literature the frequency of orchitis in adult males seems to lie between 20 and 30 per cent of all cases of mumps and the frequency of bilateral orchitis between 10 and 20 per cent of the cases of orchitis and between 2 and 5 per cent of all cases of mumps. In addition to the aforementioned reasons, relating to special conditions of selection and treatment, the discrepancies between different authors' figures may be due to the patients' age and environmental conditions. So, for example, Leineberg (1945) has pointed out that among Finnish front soldiers the frequency of orchitis was 20 per cent, whereas it was 34.5 per cent among soldiers in training camps behind the front.

The part played by the epididymis is variosly evaluated by different authors. While a large number of authors have not mentioned this localization and apparently considered it unimportant, MOUTIER (1922) emphasized that epididymal involvement occurred in 50 cases in a series of 68 cases of orchitis that he had observed. MAC GUINNESS & GALL (1944) termed the localization of mumps virus to the male gonads epididymoorchitis, because in their view orchitis is very rare without epididymal involvement. Using testicular biopsy, NORDLANDER (1948) found that in almost all of a large number of cases of mumps orchitis in the acute stage the epididymis exhibited signs of involvement in the process, but he found no evidence of obstruction.

As mentioned above, most authors have emphasized that mumps orchitis does not occur before puberty. CANDEL, WHEELOCK, & GRIMALDI (1945) queried 2368 draftees whether they had had mumps and orchitis; 1122 (47.3 per cent) claimed that they had had mumps, and 49 of these had a history of orchitis. None had had orchitis before age 10, one at 10 years of age, and the others had been 12 years or more at the time. The mean frequency of orchitis in per cent of the number of mumps cases in the age group 15–39 years was 17.6. The frequency in the group 10–14 years was 4.2 per cent, in the group 15–19 years it was 17.2 per cent. and between 20 and 24 years the frequency was 21.9 per cent.

SURVEY OF THE MORPHOLOGY AND ENDOCRINE FUNCTION OF THE TESTICLE

Since my paper to so high a degree concerns itself with such spermiogenetic and hormone production changes as may be associated with testicular atrophy following mumps orchitis, I shall here briefly review some papers on the normal gross and microscopic *anatomy* of the testicle.

The testis is an almost fusiform organ having practically equal diameters in the frontal and medial planes and a vertical diameter nearly twice as long. It should be noted already here that such measurements vary somewhat depending on how they are taken, i.e. on whether the testicle is for the moment deformed in the procedure. Usually such measurements have been performed on living subjects, and then the results will be influenced by the amount of pressure applied to the gland. Also measurements of corpse testicles

are affected by the degree of compression and purely positional factors. As a rule the gland gives a bit so that the diameter parallel to the support becomes slightly longer than the one at right angles thereto. Spangaro (1902) who measured the testicles of 10 corpses aged 19—45 published the following measurements: length 40–50 mm, breadth 20–27 mm, thickness 25–35 mm. According to a tabulation by Roessle & Roulet (1932), Schultze (1913) gave these values for adults: length 40–45 mm, breadth 20–35 mm, thickness 18–24 mm; and Mita (cit. from Roessle & Roulet), respectively: 38, 24 and 23 mm. The measurements reported by Spangaro and by Schultze shed light upon the difficulty of measuring corpse testes. It will be seen that the latter's thicknesses are much lower, while his breadths if anything are greater. This might be because the testicle was resting on something when being measured, for testes lose their turgor post mortem so that the axis parallel to the support becomes longer and the axis perpendicular to it shorter. As there is nothing to indicate how the measurements were taken one cannot definitely assert that this reason is the true one.

Data on testicular length and volume are rather rare, however, the usual practice is to give the weight of testicles that have been excised at autopsy. So, for example, Spangaro (1902) stated that from age 19–45 testicle and epididymis weigh from 20–27 g. Romeis (1926) put the weight at 15–24.2 g without epididymis. Stieve (1930) said that in 18-year olds testicle and epididymis weigh 20–25 g and thereafter change very little. Peter (1938) claimed a weight of 13.5–22.5 g in 19–45 year olds. On the basis of some earlier post mortem investigations and on their own large series of all ages—more than 500 between 21 and 60 years—, Roessle & Roulet (1932) stated that the weight of both the testes together lies between 33 and 38 g with a deviation from the mean of about ± 10 g. In a smaller series (just over 150 subjects), consisting of apparently healthy men who had died suddenly in accidents, they found that the weight was 37–42 g at ages 21–50. And in a much smaller series selected according to still stricter principles they found slightly higher values (39 to about 47 g). Sand & Okkels (1941) reported that 121 testicles averaged a weight of 40 g per pair. Having examined 177 testicles from 103 corpses, that were normal judging by histological picture and morphological spermiogenetic study, Olesen (1948) gave the wheight per testicle in normals as

13.4–44.7 g. About the same number of corpses were older and younger than 50. He found no measurable weight loss after age 50.

A few investigations have been devoted to possible weight differences between left and right testicle. Eberth (1904) found that the left testis is larger than the right, while Oiye (1928) discovered an opposite state of affairs in Japanese. By weighing 51 testes from 26 men who had been castrated for sexual delinquency, Sand & Okkels (1936) found that the mean weight for the right testicle was 20 g and for the left 19 g. In 11 persons both glands weighed the same. Consequently it was slightly more common that the right testis was a bit larger. In 6 persons the difference between right and left testicle was considerable. Olesen (1948) stated that the right testis weighed more than the left in 30 out of 50 cases. The greatest difference he came across was 6.8 g. In the age group above 50 there was a significant difference in size, the right testicle being 4.5 per cent larger than the left on the average. (By difference in size Olesen means difference in weight.)

Most authors who have examined living persons have used picture language to illustrate the size of testes, e.g. Engberg (1948) who divided testicles into size groups: 1. pea, 2. hazel nut kernel, 3. hazel nut, 4. dove's egg, 5. lying size between dove's egg and normal adult, and 6. normal. Nordlander (1948) and others have adopted a similar system.

For this purpose Hurxthal (1948) had 8 models made in the shape of a testicle and with volumes ranging from 2 to 18 ml. He stated that the latter was normal from age 18 and upwards.

Only very few investigators have measured the testes of living persons. Reich (1924) measured the testes of boys up to 16 years of age. Using sliding calipers, he measured length and thickness. He stated that the testicle is an almost fusiform organ and that its breadth and thickness have approximately the same values. He added, with no reason given, that it is not clinically possible to determine the breadth of the testicle. Reich did not measure the testicular skin duplicature, thinking that he by bidigital palpation prior to calipering could so stretch the scrotal skin and membranes that their thickness could be neglected. The only data in Reich's paper of any value for the present investigation is that the testicular measurements remain practically constant from birth up to age 12 from which time till age 16 the length increases from barely 2 cm to about 3.5 cm and the breadth from barely 1 cm to about 2 cm.

Exact measurements for adults' testicles have been given in some cases, either along two axes (Sand & Plum, 1938) or the length only (Laurence & MacGavin, 1948).

From Hansen (1949) is, so far as I can find, the only author who has undertaken to evaluate the volume of the testes in living adult males. He measured length and breadth and calculated the volume by means of the formula for the ellipsoid of revolution. Thereby he found a mean testicular volume in normal men of 23.5 ml with a standard deviation of 7 ml. Taking the mean $\pm$ twice the standard deviation, he put the extreme values for normal testicular volume at 9.8 and 47.8 ml. From Hansen claimed that 25 and 10 ml are respectively the mean and the minimum value for the volume of the testes in normal middle-aged men.

By applying the formula for the ellipsoid of revolution to the figures given by Spangaro, Schultze, and Mita, firstly using means for the three axes together and secondly the maximum and minimum values, one finds that according to Spangaro the mean total testicular volume is 35.2 ml, the minimum 20.8 and the maximum 49.2 ml. The corresponding results with Schultze's figures are 25, 15 and 40 ml. The data given by the last of these authors yield a value of about 22 ml. Spangaro's series was smallest but it is most reliable of the lot in so far as the age is given. Among the above volumes 35.2 ml agrees best with previous findings, that the testes are about equally large and weigh approximately 40 g (Sand & Okkels). It will be seen that volumes as calculated above vary considerably. The lowest total volume, 15 ml, evidently far exceeds the one, 10 ml, given by From Hansen. However, judging by the weight given for a normal testicle pair, From Hansen's figures must obviously be too low, i.e. the volume cannot be computed exactly enough in the above manner.

Having no reason to take up the normal microscopical anatomy of the testicles, I shall here remain content with mentioning a few papers that have some bearing on my own problems.

Most authors are agreed that the histological picture of the normal testicle varies widely from case to case and that one seldom sees a testicle with a complete set of normal and histologically perfect tubuli. There has been a heated discussion, however, as to what is meant by normal in this respect. One extreme is represented by Kyrle (1920) who considered it very rare indeed in both growing boys and youths as well as in adult men to see a testicle containing no regions with atrophied tubuli. His conception of normalness

was, however, very stringent: adjacent tubuli must not be separated by appreciable amounts of interstitial tissue. The opposite extreme is represented by LEUPOLD (1920), who maintained that there may be some interstitial tissue but that it must be largely composed of Leydig's cells, and by SCHINZ & SLOTOPOLSKY (1925), who had a similar opinion but maintained that the interstices could be composed of loose connective tissue. No reliable methods exist of determining the relation between tubuli and interstitial tissue (SAND, 1935); and, moreover, the same testis may show considerable variation in amount of interstitial tissue and number of Leydig's cells (SAND, 1918, 1933; STIEVE, 1930) and the interstitial tissue is more abundant at the poles than at the equator (STIEVE). In 33 adult, healthy persons aged 20–71 years (mean: 41), who had died suddenly through suicide or acute disease, SAND & OKKELS (1936) found a fully "normal" testicular tissue in only 8 cases, a not quite normal ("la pathologie normal") in 12 cases, and more or less severe lesions —especially of the tubuli—in 13 cases. Several authors (KYRLE, 1920; SLOTOPOLSKY & SCHINZ, 1924; SAND, 1933; STIEVE, 1940, 1942; STAEMMLER, 1942) have drawn attention to the extreme sensitivity of the spermal epithelium to various kinds of maltreatment. SAND (1933) even called the testicle the most sensitive organ in the body. Seeing that pathological changes are so common, ROMEIS (1926) maintained that testicles without extensive atrophied areas are normal, and SLOTOPOLSKY & SCHINZ (1925) discussed the "normal pathology" of the testicle.

It appears from the works just reviewed that the germinative testicular tissue is highly sensitive to insults of different kinds. The interstitial tissue, on the other hand, is considered far more resistant to testicular lesions, and atrophic changes in its cells are seldom reported.

In view of the variability of the histological picture, it may be mentioned that a certain degree of degeneration may be quite normal. It is possible also that the tubuli readily degenerate under the action of various insults, such as mechanical force and, chiefly, toxic activity and temperature. The permissible extent of tubular degeneration without going beyond the "normal" has probably never been estimated.

A valuable method of examination, testicular biopsy, was introduced in 1913 by HUHNER. The original procedure was to puncture and aspirate, but nowadays the usual thing seems to be excision

of a sample. This method, introduced by Engle and used first by Hotchkiss & Charny (1940), has provided valuable information regarding the condition of the testicles. Its limitation is that it does so in only a small part of the testicle, while in point of fact conditions in various parts of the testicle may, as we have seen, vary quite a lot as regards the spermiogenesis (Kyrle, Schinz & Slotopolsky).

In regard to the age distribution of my own series it is rather interesting to study age changes in the testicles and the question of how long the spermiogenesis usually remains lively enough to guarantee fertility. Roussle & Roulet (1932) found no appreciable loss of weight up to age 60 in their previously mentioned series.

Having found no appreciable loss of weight in his previously mentioned series. Olesen (1948) stated that the testicular size varies more in men over age 50. Whether or not the testis exhibits any typical age changes, and if so what they are, has been discussed by many investigators. Spangaro (1902), Eberth (1904), Rössle (1917). and Hirsch (1926) asserted that aging is associated with progressive testicular atrophy and loss of weight. Branca (1928) was of the opinion that normal senile involution exists, whereas Sand (1933) was doubtful whether it is a normal aging process or the effect of all lesions that during life have occurred in the extremely sensitive testicular tissue. Stieve (1930) pointed out that all the described changes in the atrophied senile testicle also have been observed in young men. He even went so far that he stated that the testicular function may be as good in a healthy elderly person as in a young man.

Examples have been given of preserved spermiogenetic function in the testicles of very old men. Thus, Seymour, Duffy & Koerner (1935) described the case of child born in the marriage of a man of 94, whose spermiogram upon examination turned out to be normal. In his series of 174 men, 70 of whom were 55 years or older and the eldest 83, Olesen (1948) found no appreciable increase in the number of abnormal spermal heads.

The first time the *endocrine function* of the testicle was demonstrated was in 1792, when John Hunter showed that the function of seminal vesicles and prostate was dependent upon the testis. Berthold (1849) demonstrated that transplantation of testicular tissue can prevent atrophy of the comb and wattles in castrated cocks. Brown-Séquard (1889) reported beneficial effects on the organism after in-

jections of ground testicular tissue suspended in water. He believed, as did his contemporaries, that the effect was due to some substance produced by the germinative tissue. Though the value of this observation has been questioned, the observations stimulated continued research into testicular function and all other branches of endocrinology as well. In the next decades the endocrine function of the testicle was mainly studied in castrated animals, natural and experimental kryptorchism, after administration of testicular extract, testicle transplantation, vasectomy and roentgen irradiation of the testes. Bouin & Ancel (1906) studied the endocrine function of the testicle in kryptorchism and used extract from ectopic testicles to overcome the endocrine dysfunction of the testicle after castration. They asserted that the male sex hormone is formed in the interstitial cells. McGee (1927) made a lipid extract from bull testicles and showed that it contained substance which stimulated the growth of the cock's comb. Simultaneously, and independently, Loewe, Voss, Lange, & Wähner (1928) and Funk & Harrow (1929) demonstrated the presence of such substances in men's urine. Active androgens were isolated from male urine in crystalline form by Butenandt & coworkers (1931, 1932, 1934, 1935). Male hormone in crystalline form was isolated from mammalian testicles by David, Dingemanse, Freud, & Laqueur (1935) who named their product testosterone. Testosterone has never been extracted from any biological material other than testicular tissue. Laqueur & coworkers (1931, 1935) showed that the active androgenic substances extracted from urine and from testicles are not identical. Ruzicka (1935) synthetized androsterone from cholesterol.

Oestrogenic substances have also been demonstrated in the male organism. Fellner (1913, 1921) and Laqueur & coworkers (1926) showed that testicular extract contains substances whose action is similar to that of oestrogens. Häussler (1934) and Zondek (1934) stated that the urine of stallions contains oestrogenic substances in large quantities and that these quantities are considerably reduced after castration. However the organism seems to be capable of converting androgens into oestrogens (Zondek, 1934; Steinach & Kun, 1937; Callow, 1938), but according to Eng (1937) the amounts converted are insignificant.

Bouin & Ancel, as noted previously, maintained that the male sex hormone is formed in the interstitial cells. Other researchers,

e.g. Stieve (1921) thought that it is produced by the germinal tissue, again others left the question open. Though various reports by different authors have not given absolutely similar results, it seems nowadays to be taken for granted that the male androgenic hormone is produced in the interstitial tissue. As Ancel & Bouin and many other authors have shown, the germinal epithelium is often atrophic in kryptorchism where as the interstitial cells are unaffected. The same is the case after roentgen irradiation in suitable doses. In both instances the androgen production of the testicles is unimpaired, which is proved bythe non-atrophy of the secondary sex organs. In both men and women, moreover, Leydig's cell tumours bring on signs of an increased production of androgens.

Oestrogens are produced in the tubuli, to be exact in the Sertoli's cells, which has been shown chiefly by the thorough experimental studies by Törnblom (1942) and by reports on tumours in the cells of Sertoli by Greulich & Burford (1936), Zuckermann & McKeown (1938), Huggins & Moulder (1945), Hooker (1948), Berthrong, Goodwin & Scott (1949) and Teilum (1950).

Yet another hormone has been isolated from testicles. Ruzicka & Prelog (1943) isolated from swine testicles a substance, Δ^5-pregnenolone, which Selye (1947) showed to have a stimulating effect on spermiogenesis, apparently without concomitant beneficial effects on atrophy of Leydig's cells or prostate.

The existence of an interrelationship between pituitary gland and testicles is well established. Fichéra (1905) found that the pituitary body increases in weight and the eosinophil cells in its anterior lobe proliferate after castration. Smith (1927) and Smith & Engle (1927) demonstrated that hypophysectomy brings on atrophy of the testicles and accessory glands and that the atrophy can be reversed by transplantates from the anterior lobe. They were also able to show that in castrated animals the effect on the acessory glands did not set in, *viz.* that it was a matter of a gonadotropic hormone. At the same time, Zondek & Ascheim (1927) showed that the urine of pregnant women contains a substance which stimulates egg maturation in immature mice (the Ascheim-Zondek test for pregnancy). Furthermore, they could discriminate between follicle-stimulating and luteinizing urine, and they concluded, therefore, that the pituitary gland secretes two different hormones. Hamburger (1931, 1933) showed that the urine of castrated men

contains an increased amount of follicle-stimulating hormone. Fevold, Hisaw, & Leonard (1931) reported that they were able to distinguish between follicle-stimulating and luteinizing hormone. It seemed probable, after papers by Greep & coworkers (1936, 1937), that the male pituitary body produces two different gonadotropic hormones, of which the follicle-stimulating one has a stimulating effect on the germinative epithelium, while the luteinizing principle stimulates the interstitial cells and their ability to produce the male androgenic steroid. The luteinizing hormone (LH) is therefore also called interstitial-cell-stimulating hormone (ICSH). The demonstrated ability of this hormone to stimulate the spermiogenesis was attributed to the spermiogenesis-stimulating effect of androgens (Walsh, Cuyler, & McCullagh, 1934; Nelson & Gallagher, 1936; Simpson, Li & Evans, 1944).

The weight of the pituitary gland and the production of gonadotropic hormone are, as mentioned previously, increased in castrated animals. Having by roentgen irradiation induced atrophy of the germinative epithelium in animals, Mottram & Cramer (1923) launched the theory that the germinative epithelium is the seat of production of a hormone that has an inhibiting effect on the pituitary production of hormones. Martins & Rocha (1931) showed that parabiosis with a castrated male animal gave rise to premature sexual maturity in an immature female animal, whereas parabiosis with a normal male animal had no such effect. Nor was there any effect if testicular tissue had been implanted in the castrated animal. On the basis of observations in parabiosis with cryptorchid animals they drew the conclusion that the germinative tissue of the testicle produces a hormone with an inhibiting effect on the pituitary gland. The experiments were continued and developed by McCullagh & coworkers (1932, 1934–1936, and later) who considered that the germinative tissue produces a hormone which they called "inhibin" because of its inhibiting effect, when the testicle functions normally, on pituitary secretion of gonadotropin.

Moore (1935, 1937, 1939) maintained that no observations suggested that more than one hormone is produced. But he did not think it impossible that the germinative tissue participates in the hormone production, and he therefore proposed that the question be left open for the time being. Nelson (1937, 1948) considered the existence unproved of an inhibiting hormone and asserted that the changes observed in the pituitary body and accessory sex or-

gans can be explained by the production of a single hormone, testosterone, in the testicle. He admitted the possibility, however, that the germinative tissue secretes oestrogens, especially with regard to the aforementioned observations in Sertoli cell tumours.

Klinefelter, Reifenstein, & Albright (1942) described a "syndrome" characterized by small testes, gynecomastia, aspermia, normal production of androgens, and raised FSH secretion. They explained the syndrome by the absence of a hormone produced in the tubuli, "X" hormone, which inhibits FSH production in normal men and, likewise, inhibits the stimulating effect on the mammary glands that they ascribed to testosterone. They supposed, on the other hand, that "X" hormone might have a stimulating effect on the secretion of ICSH in the pituitary gland. Heller & Nelson (1945) have later described the same symptom without gynecomastia.

Törnblom (1942) examined male rats with ischemia in the testes which he had treated with fractionated roentgen irradiation with consequent atrophy of the germinative tissue. In the animals he found that the pituitary gland had gained weight and, concomitantly, hypertrophy of the prostate. Testosterone in doses sufficient to cause enlargement of the prostate in castrated mice were unable to prevent castration changes in the pituitary gland. He was able, moreover, to isolate from testicles a fraction whose biologically active principle was similar to oestradiol. In small doses this principle inhibited the weight increase of the pituitary gland in castrated male rats without affecting the weight of the prostate. The same effect was obtained following treatment with oestrogens. By these researches Törnblom could prove his hypothesis: that the germinal epithelium of the testicles produce a hormone that inhibits the gonadotropin secretion of the pituitary gland and, consequently, also inhibits the stimulating effect of gonadotropin on the production of testosterone, and that the hormone in question is one of the oestrogens.

Several authors have schematized the interplay between the spituitary gland and the gonads. In the discussion of my own results I shall return to these matters in conjunction with the interplay between the pituitary gland and the gonads following mumps orchitis.

It should already be pointed out here, however, that many facts of the problem are obscure and the schematic theories in part are based on unsubstantiated hypotheses.

It has long been known that orchitis may be followed by partial or complete *testicular atrophy*. Plenty of different estimates have been put forward as to the frequency of such atrophy, and it of course matters quite a lot how soon after the disease a patient is examined for atrophy. According to a compilation by COMBY (1898) of earlier French authors' works, orchitis is followed by atrophy in more than half the cases. Different authors have probably used different criteria, which was pointed out by WESSELHOEFT (1000). In a compilation of a number of works, including part of those reviewed by COMBY, he (WESSELHOEFT) found a frequency of 190 cases of atrophy out of 347 cases of orchitis, i.e. 54.7 per cent.

The investigation mentioned above by CANDEL et al. (1945) showed that 27 of 49 orchitis cases got atrophied testes, i.e. a frequency of 55 per cent. Of these 9 showed atrophy to 1 3 of normal size. 12 to 1/2 and 6 to about 2/3 of normal size. LAURENCE & MCGAVIN (1948) reexamined 203 American soldiers, who had had mumps during their military service and whose mean age was 22 years, from 4 to 10 months after the disease. Orchitis had been present in 31 of these. The authors compared the length of both testicles and suspected atrophy when the difference between the two sides exceeded 0.6 cm. They themselves thought that this criterion was open to discussion, for even healthy men may exhibit a difference. In 31 cases (57 per cent) the testicles were unatrophied and altogether normal. Some degree of difference was found between the healthy and the affected side in 22 cases (42 per cent): a difference of 0.5 inch (1.25 cm) in 3 men, 0.75 inch (1.9 cm) in 10, 1 inch (2.5 cm) in 7 and 1.25 inch (3.2 cm) in 2. Of these 22 pairs of testes 4 were softer than their healthy counterpart on the opposite side. Unfortunately the authors gave no information on the atrophy in 5 bilateral cases, but the conclusion can probably be drawn that there was no case of bilateral atrophy. NORDLANDER (1948) found by clinical examination atrophy in most of 105 cases of mumps orchitis combined with sterility, which is natural since the series was selected on the basis of sterility. It is interesting to note that he could demonstrate no atrophy of the testes in some cases in which the spermiogenesis was considered faulty. In 51 cases, in which he thought himself safe in excluding other diseases that could have affected the testicles, he found bilateral atrophy in 17, i.e. one third.

Some investigators have studied the microscopic picture in the acute phase of mumps orchitis (DOPTER & REPACI, 1909; SMITH,

cited from Wolbach, 1912; Manca, 1932; Rocchi, 1933; Seguy, cited from Dalarue, 1942; Charny & Meranze, 1942; Simmons & Sniffen, 1947, Nordlander, 1948, Howard, Sniffen, Simmons & Albright, 1950). Manca (1932), just as Nordlander (1948), has pointed out that such investigations are of limited value in evaluating the outcome of the inflammatory process.

A small number of authors (Malassez & Reclus, 1881; Stoltz, 1901; Hall, 1912; Reuscher, 1927) have described the microscopic picture in the testicle some months or years after an attack of orchitis. The authors observed total or partial parenchymatous sclerosis, particularly involving the seminal vessels, but usually not at all affecting the interstitial tissue. The cases are too few, however, and sometimes complicated by other changes (tuberculosis, hemorrhagic infarction), so any general conclusions can hardly be drawn.

Aiming to study the microscopic picture in the testicle during and after an attack of mumps orchitis and to compare it with the spermiogenesis, Nordlander (1948) biopsied the testes of 18 men, most of them in their twenties, in the acute phase of the disease and 34 men of various ages with a history of mumps orchitis who had consulted him for inability to beget children. From the latter group the author separated 19 cases, of which 17 were bilateral, which he labelled "pure" cases since in them he thought he could safely say that other processes were absent which might have affected the testicles. The author distinguished between three phases in the course of the disease: the acute, the retrogressive, and the final phase, i.e. the definitive condition setting in after orchitis. The first stage is characterized by inflammatory changes in the interstitial connective tissue, whence exudate seeps through the more porous membrana propria to the seminal vessels so that the spermiogenetic tissues can be destroyed in a few days. The author believed that he in addition to this direct damage could observe degenerative changes due to thermic and possibly also toxic activity. "Leydig's cells suffer remarkably little degeneration."

The retrogressive phase is characterized by various conditions subsequent to the acute phase. In mild cases the exudate may be reabsorbed in a week or two, and the orchitis seems to heal without permanent tissue damage. In severer cases the seminal vessels are more or less completely destroyed and hyalinized. Also in this stage, which may lasts for months or even years, Leydig's cells are remarkably unaffected.

In the third phase, that which follows after an attack of orchitis is over, the testicle is more or less atrophied and the testicular turgor reduced. While usually the seminal vesicles in different sections are about equally hyalinized, a degenerated vesicle may have neighbours with unaffected or almost unaffected spermiogenesis. The author has nothing to say concerning Leydig's cells in this phase.

Nordlander reported that he had observed that orchitis may take an insidious subclinical course, hwich he called "quiet mumps orchitis." He also claimed to have demonstrated a transitory degeneration in the clinically intact testicle's spermiogenetic tissues, which he assumed gives rise to a usually transient sterility.

STERILITY

Most authors who have discussed the question of orchitis with subsequent testicular atrophy in mumps have pointed out that this change may be accompanied by sterility. Similarly, the literature contains data indicating that mumps orchitis is not an uncommon cause of sterility in men. How common sterility is after bilateral mumps orchitis is a problem about which opinions have been at great variance. Comby (1898), Abraham (1912) and Aaser (1915) declared that bilateral testicular atrophy after orchitis always gives rise to sterility, while Benard (1927) on the basis of a large series (175 000 cases of mumps) stated that sterility practically never is caused by mumps. The literature includes solitary casuistic reports on sterility after mumps orchitis (Giovanni, 1913; Brosius & Schaffer, 1933; Seguy, 1942; Hotchkiss, 1944).

Investigators who have studied the causes of sterility in men, and then usually have observed series of men who had applied on the grounds of childless marriages, have usually stated that sterility is not seldom caused by mumps orchitis, but that disease has usually not been very frequent in the observed series. Varnek (1943) studied sperm samples from 265 men and found that 27 lacked or contained very few spermatozoa. Only one of the patients had a history of mumps. Hammen (1944) described a series consisting of partly 291 men, whom he had subjected to clinical examination and sperm test, and partly 634 men from whom only the semen had been studied. In the former group he found 3 cases of orchitis, of which one certainly and one probably was mumps orchitis, and in the latter group 5 cases of mumps orchitis, 2 of which were bilateral. Sim-

MONS (1947) stated that he only had seen one case of bilateral mumps orchitis among the more than 1000 childless men whom he had examined. JEFFCOAT (1946) examined the men in 743 sterile marriages, in 12 of which cases the reason might have been mumps. KOERNER (1946) found that mumps with orchitis was a possible cause of sterility in 19 out of 184 cases and next after gonorrhoea he considered it the commonest reason for sterility in men. ABESHOUSE (1947) in a series of 500 sterile men 37 cases of complete aspermia, in 6 of which the cause might have been mumps orchitis. NORDLANDER (1948), having examined 1311 men in sterile marriages, found that mumps orchitis was the probable cause in 105 cases, i.e. about 8 per cent.

There are two ways of evaluating the role of mumps as a cause of sterility: either to investigate how often sterile men have a history of mumps or to study the fertility of a fairly large number of men who have had mumps. However, to express the frequency of sterility after mumps as a percentage of all kinds of sterility is not quite satisfactory. For then the magnitude of the figure will be influenced by the extent to which other causes of sterility are represented in the population. For example, the percentage will probably be far lower in a metropolitan population in which gonorrhoea is a more important cause of sterility than in a rural population that is not as exposed to gonorrhoea. It would be more correct to express sterility after mumps in per cent of the men in fertile age or in per cent of the men who have had mumps. By observing a series of men with sterile marriages it is consequently impossible to obtain a reliable opinion as to the role of mumps as a causative factor in sterility, but only as to its role in proportion to other such factors. So far as I can find the literature contains no statement on the frequency of sterility after mumps, respectively unilateral and bilateral orchitis, as determined by reexamining a series of persons who have had mumps.

HORMONAL IMBALANCE FOLLOWING MUMPS ORCHITIS

Changes in the secondary sex characteristics and libido following mumps orchitis are reported in old French literature. After a severe attack of bilateral mumps orchitis in a 22-year old soldier, LEREBOULLET (1877) observed pronounced testicular atrophy within 3 weeks and after 4 months pronounced marked changes in the secondary sex attributes. The soldier had exhibited normal

signs of virility before the disease. Four months after it he showed marked enlargement of the mammae with a venous network in the skin, beardlessness and absent growth of hair on the chest. Formerly frequent and usually followed by ejaculation, erections were absent and so was libido. The penis was normally developed, though, and pubic hair was present. According to COMBY (1893) the patient was re-examined 4 years later by LAVERAN who, however, found neither "feminism" nor mammary hypertrophy. But he did note that the patient was impotent and absolutely frigid and that his testicles had atrophied to the size of a pea.

In this connection it should be noted that changes in the secondary sex characteristics hardly are to be expected after orchitis, at least judging by experiences of castration, when it attacks a grown up man. This is why the above case is particularly interesting. It shows that features like feminism are judged very subjectively, since the later author found no such signs while the earlier did. Also GERHARD & DOGNY, according to COMBY (1893), have found several cases of impotence after atrophying mumps orchitis (partial atrophy in 15 cases), and LAURENS observed reduced libido and potency in 9 cases, the symptoms being mild in 6 and severe in 3 cases. LAIGNEL-LEVASTINE & COURBON (1917) reported on one case, also a 22 years old soldier, in which there was pronounced bilateral atrophy of the testicles 7 months after a severe attack of mumps with bilateral orchitis. The patient also exhibited mammary hypertrophy and lost all interest in athletics, which previously had interested him highly; he became more feminine. Before the disease his coitus frequency had been high and after it he did feel a slight sexual stimulation, but he could only rarely perform the act which fatigued him inordinately. WESSELHOEFT (1920), having reviewed these cases, remarked that it would be most surprising if testicular atrophy in a 22-year old could give rise to so-called feminism, since castration at the same age levels does not give rise to the same result. Though no cases are described in the literature (which is natural in view of the rareness of mumps orchitis before adolescence), such changes are said to be possible following testicular atrophy before or during adolescence.

In addition to the above cases, JANBON, ALQUIÉ & VIDAL (1937) referred to a case published by MIRANDA (1933). The authors took up also the following disorders in conjunction with mumps: ovarial dysfunction, diabetes mellitus, Basedow's disease, suprarenal in-

sufficiency, hirsutism, and diabetes insipidus with obesitas. Moreover, they described a case of their own, in a woman of 20, of mumps with meningitis, pericarditis sicca, pancreatitis and hyperthyroidism.

Laurence & McGavin (1948) found in their aforementioned reexamination of 53 soldiers who had had mumps orchitis that their sexual activity, considered in terms of coitus, masturbation and nocturnal emissions, was unchanged 4—10 months after the disease. As mentioned before, none of the group exhibited pronounced testicular atrophy, at least not bilaterally. The sexual activity was unchanged in a man, one of whose testicles already was atrophied before the attack of orchitis, but his orchitic testicle was not demonstrably affected. The authors did not go beyond simple measurements such as volumetric and consistency determinations.

Hormonal Production in and after Mumps Orchitis. Selsø (1943) seems to be the only one who has studied hormonal production during the acute phase of mumps. In uncomplicated mumps he found normal values for testicular hormone, oestrogens and gonadotropic hormone. Using the cock's comb test (Fussgänger) in 8 persons with orchitis in the acute phase, he found depressed values for the secretion of active androgenic hormone. He found no effect on the production of oestrogens and gonadotropic hormone. In most of the subjects the values gradually returned to normal, but 6 months later the values were still low in 2 patients, though one of them meanwhile proved capable of conceiving. The author pointed out that an observation time of half a year is too short.

Simmons & Sniffen (1947) described one case, and Howard, Sniffen, Simmons, & Albright (1950) the same case and another 2 cases of hormonal imbalance following mumps orchitis. The first subject was examined at age 31 after having had bilateral mumps orchitis at age 15. When examined, his testes were small, the 17-ketosteroid production was 8.9 mg per day, the FSH secretion exceded 104 m. u. per day, and he had aspermia. Testis biopsy revealed complete tubular sclerosis, interstitial fibrosis and normal Leydig cells. Of the other two cases one was that of a man aged 50 years who had undergone bilateral mumps orchitis at age 25. He had small testes, secreted 2.0 mg 17-ketosteroids per day, and more than 192 m. u. FSH per day. His spermiogenesis was not assayed. Testis biopsy revealed focal areas showing normal tubules and many normal Leydig cells, elsewhere complete tubular sclerosis, interstitial fibrosis and small groups of normal Leydig cells. He had

been married for 15 years without children but with normal potency. The year before the examination he had been examined for hyperparathyroidism, and the hypertrophic glands were removed then. He also had chronic lymphatic leukemia with splenomegaly. When examined, his hair distribution, voice, breast, prostate and phallus were normal. The third case was that of a man aged 31 years who had undergone bilateral mumps orchitis the year before. He had been married for 3 years and had 1 child before he fell ill. His physique was normal, including the size of both testes. The sperm count about 9 months after the disease was 17 millions per cubic centimetre with 95 per cent motile, but the semen showed only rare sperms one month later. Urinary 17-ketosteroids were 8.9 mg per day. FSH assay 18 months after the disease by the dialysis method was greater than 104 m. u. per day, and 8 months later by the non-dialysis method it was greater than 192 m. u. per day. Testis biopsy about 1 year after the disease revealed focal areas of tubular sclerosis and interstitial fibrosis, elsewhere the tubules showed variable activity and rather numerous but normal Leydig cells.

From Hansen (1949) determined the concentration of acid phosphatase in the prostate exprimate and the androgen production. One of his patients is said to have had mumps and another mumps orchitis, but data on bilaterality etc. are not given. Both had testicular atrophy. Both showed normal androgen production and a normal amount of pubic hair.

Atrophy of the prostate following mumps orchits has been reported by Robinson (1915) who observed it in 7 cases, 5 of which also exhibited testicular atrophy.

PART I

STATISTICS OF MUMPS IN SWEDEN

1

CHARACTER OF THE CASES INVESTIGATED

In the first place I have studied the statistical data in the annual reports from the Swedish forces', particularly the army's, medical services ("Hälso- och sjukvard inom armén") and other official documents in the archives of Armed Forces' Medical Administration, chiefly monthly (quarterly) sickness returns from the military units. These data refer to the years 1912–1948 inclusive, and the Armed Forces' Medical Administration has no figures from the years prior to 1911. As they are drawn up at present the official reports have only a limited value for ascertaining the incidence of mumps. It would, for example, be interesting to know the number of conscripts who have been declared, temporarily or permanently, unfit for military service on account of mumps or its aftereffects. No such figures are given. Moreover, some of the basic figures that would be required for the calculation are confidential for reasons of military security.

However, official figures for the number of conscripts enrolled each year are given and so are the number of persons annually declared unfit for military service as well as the number of persons enrolled in other services than the army. In the years 1925–1938, though, all fit conscripts were not given military training. In 1931, for example, 16 031 conscripts were enrolled in the replacement reserves; and it is estimated that only about half this number (8000) have since had any military training. Consequently the figures for the number of conscripts in service each year are only approximate.

The official reports do not give the number of service days lost per annum in each separate disease. I have therefore used sick lists from some different troop units and different years as well as quarterly (monthly) sick returns for 1942 from various troop units to extract adequately reliable means for the number of sick days in mumps. The figures so obtained comprise partly 536 cases of mumps from

6 different units 1919–1926 (LAMBERT, 1947) and partly 2053 cases from a large number of field units 1942. But it must be stressed that such figures are means; and if they are to be used for calculating the training or service time lost on account of mumps it must be kept in mind that they are minimum figures. Usually the conscript does not fully resume his duties immediately after being discharged from hospital; he either gets sick leave or is given lighter duties. In order to get an estimate of the mean number of days that elapse after the conscript's discharge from hospital before he fully resumes his duties, I have analyzed the service records for 180 conscripts from 4 units who were treated for mumps 1945–1946. The figure obtained thus cannot be very precise but it should be exact enough to give some idea concerning the role of mumps as a cause of lost service days.

Furthermore, with the object of estimating the incidence of mumps and mumps orchitis at different ages up to conscript age (20–21 years), I have issued a questionnaire to conscripts. The conscripts were asked to fill in place and date of birth, place of schooling and employment, if he had had mumps and if so at what age, how long he was ill, if he had been treated at a hospital, if there had been any complications after the disease, particularly if it had been localized to the genitals, and lastly if he had had the disease more than once.

In 1944 I sent out such questionnaires to all conscripts of age class 1942, 698 conscripts, at one troop unit (LAMBERT, 1947) and to 7930 conscripts at 11 Swedish regiments in connection with their first term of service in 1945. The difference between these two sets of replies is that the first lot was filled in after completed recruit service (during emergency service) and the second lot immediately after reporting for first service. In the former case, therefore, some of the conscripts had had mumps while being called up.

About 8 per cent of the conscripts claimed they did not know whether or not they had had mumps. This figure gives some indication as to the reliability of the replies. When such a large proportion of the questionees are unsure of themselves, it shows that the question refers to an event in so tender years that the person concerned no longer remembers what took place. It follows, as a corollary, that some of those who are uncertain on rather weak grounds give a definite answer. In other words, the person's statement as to whether he has had or has not had mumps may sometimes be unreliable. There is some possibility of checking up on this by virtue of the fact

Table 6. Conscripts from Various Regiments Classified According to Environment when Growing up.

Regiment	Born in rural district, school in rural district	Born in rural district, school in town	Born in town, school in rural district	Born in town, school in town	Doubtful	Total
	I	II	III	IV		
I 2	454	22	16	79	12	583
I 6	437	23	44	153	15	672
I 7	457	34	64	196	—	751
I 11	485	22	18	51	3	579
I 15	520	28	59	148	11	766
I 17	370	29	35	290	10	734
I 18	555	51	35	101	28	770
I 19	980	40	7	45	13	1 085
I 20	606	19	6	23	10	664
I 21	706	5	19	32	12	774
A 3	418	15	36	83	—	552
Total	5 988	288	339	1 201	114	7 930
In per cent	75.5	3.6	4.3	15.2	1.4	100.0

that cases of mumps during the period of military service were registered among the questionees. It is possible that a small number of those who previously had suffered from mumps might get the disease again, but if the statements as to prior mumps were very faulty a relatively large proportion of those who claimed to have had mumps would again get the disease during their military service.

The regimental distribution of the conscripts in the second series appears in table 6. The recruitment areas of the regiments (corresponding to enrollment areas) are marked on the map in fig. 1. All the units are regiments of infantry whose recruitment areas coincide with enrollment areas ("io") with the same number, except "A 3" whose recruitment area roughly covers enrollment areas 6, 7 and 11.

The statements as to place of birth and schooling were not checked. To do so with regard to the place of birth would have been possible with the help of the personnel office at the regiments or by application to church authorities. Such a check-up, which would have given considerable extra work to the persons involved, was not

Fig. 1. Enrollment areas (I o) for the queried conscripts.

thought essential; for on this matter lacking knowledge or loss of memory cannot have been the reason.

It is naturally important to know whether the case records are representative from a point of view of proportionality between rural and urban population. According to the 1945 census there were in Sweden on December 31st 1945 48 410 men aged 20–21 (twelfth part sampling) of whom 29 820 (61.6 per cent) lived in rural districts and 18 590 (38.4 per cent) in cities. Judging by the place of schooling it will be seen that about 80 per cent of the persons in the author's series had been living in the country during that period of their lives (groups I and III) while about 20 per cent had lived in towns (groups II and IV). A closer analysis of a portion of the replies (those from the 2nd Infantry Regiment) revealed that about 10 per cent of the country boys said they had taken employment in towns after school age and about 4 per cent of the town boys had taken jobs on the land. The questionnaire did not give the place of domicile at the time of reporting for duty. Some degree of urbanization has probably taken place, however, so the figures are probably more representative of the population as a whole than the above data would lead one to suppose. It should be noted, besides, that the subdivision into rural and urban populations is very schematic, for several villages and municipal and country communities in Sweden have more inhabitants per square kilometre than many towns. Moreover, the borderline between rural and urban population may be variously drawn. The limit used in official statistics perhaps may be different from that used by the persons themselves.

Altogether 114 questionnaires, or 1.4 per cent, were discarded because of incompleteness, e.g. that place of schooling was not given or that the person concerned had been born or educated abroad.

The age when the questionee had mumps must naturally be rather an uncertain quantity. Some people give their age at their next birthday, others give it at the preceding birthday. This may affect the age given for the attack of mumps. The statement will be still more affected by the difficulty of remembering the exact time for a fairly unimportant disease. The latter source of error, however, should even out between the different age groups and have an equal effect in the different groups that are compared in this treatise.

The material also includes diaries kept at military station hospi-

tals and other records concerning those among the questionees who suffered from mumps during their year of military service. With regard to the existence of mumps the conscripts were accordingly followed during their term of service from April 1945–March 1946. Thus, the available data permits a computation of the number who had mumps while being called up and the number of these who had had mumps before, and if so at what age.

2

EPIDEMIOLOGY OF MUMPS

INCIDENCE OF CHILDHOOD MUMPS IN CONSCRIPTS, WITH SPECIAL REFERENCE TO ENVIRONMENT (URBAN OR RURAL UPBRINGING)

In my first series, comprising 698 questionnaires completed in 1944 by conscripts on service, 29.9 per cent reported having had mumps before commencing their term of military service. While this age class was called up for recruit service numerous cases of mumps occurred at the various units, so that 18.6 per cent of the questionees then caught the disease. Consequently 49.3 per cent of the questionees, who were about 23 and had completed their first service, had had mumps. Among the conscripts in the second series 45.8 per cent reported having had mumps before being called up the first time. During service 3.8 per cent fell ill. After service mumps had thus occurred in 49.6 per cent of the latter series. It will be seen that these figures agree fairly well. That there is a difference is only natural, for the incidence of mumps varies from year to year and hence the number of persons who have had the disease should also vary, even if the different epidemics overlap. Susceptibles who are not infected in a first epidemic may be in a second.

It would now be interesting to see if the frequency is the same in urban and rural populations. In point of fact, however, people just do not grow up and settle on the land only or in cities only. Therefore such a classification must be rather more differentiated. Distinction is made in this work between those who were born and schooled in rural districts (Group I), those who were born in the country and schooled in a city (Group II), those who were born in a city and schooled in the country (Group III), and those who were born

Table 7. Queried Conscripts Classified According to Previous Mumps and Environment when Growing up.

Group[1]	Total = N	Earlier mumps					
		"Yes"		"No"		"Don't know"	
		No.	per cent of N	No.	per cent of N	No.	per cent of N
I	5 988	2 729	45.6	2 806	46.9	453	7.6
II	288	142	49.3	120	41.7	26	9.0
III	339	139	41.0	179	52.8	21	6.2
IV	1 201	581	48.4	508	42.3	112	9.3
Doubtful	114	37	32.5	45	39.5	32	28.1
Total	7 930	3 628	45.8	3 658	46.1	644	8.1

Table 8. Frequency of Mumps in Men Prior to Conscription (< age 20), Classified According to Juvenile Environment.

Group	Born in	School in	No. of queried conscripts = N[2]	of which conscripts with mumps before conscription	
				No.	Per cent of N
I	rural district		5 535	2 729	49.3 ± 0.7
II	rural district	town	262	142	54.2 ± 3.1
III	town	rural district	318	139	43.7 ± 2.8
IV	town		1 089	581	53.4 ± 1.5
		Total	7 204	3 591	49.8 ± 0.6

and schooled in a city (Group IV). In table 6 and 7 the queried conscripts have been thus classified.

The percentage frequencies of mumps in these four groups are given in table 8. It will be seen that groups I and III exhibit the lowest figures, whereas groups II and IV lie on a much higher level. The difference is nevertheless hardly greater than can be accounted for by the varying incidence of mumps in different years and regions. It should be noted. furthermore, that table 8 neither includes

[1] As regards the groups I—IV see table 8.

[2] "Don't know" responses (644 cases) and persons from unknown environment (82 cases) excluded.

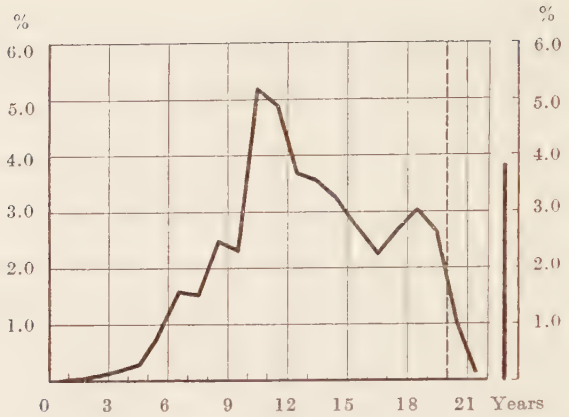


Fig. 2. Total number of conscripts (groups I—IV combined) with mumps in different ages in per cent of all questioned. The column to the right gives the frequency during the military service.

those who claimed not to know whether or not they had had mumps, nor those who supplied incomplete data on where they were born and had gone to school. The rejected questionnaires, about 10 per cent of the total, should however come in about equal numbers from the different groups.

The author classified the conscripts in the first series into city and country boys, according to their environment at birth. The resultant groups exhibited a statistically probable difference with respect to the frequency of mumps before military age. Of the country boys 27.2 ± 2.1 per cent had had mumps. So had 38.3 ± 3.5 per cent of the city boys. The difference is 11.1 ± 4.1 per cent.

A more diversified picture may be had by using data supplied by the recruits in the construction of frequency curves for the occurrence of mumps at various ages. Table 9 contains percentage annual frequencies of mumps in different age groups, as well as cumulative frequencies for the entire series and each of the above four groups. The series is too small to permit any far-reaching conclusions, but the table and fig. 2 suggest that the incidence is highest at age 10 and that there seems to be a difference between those who went to school in cities and those who went to school in the country. During childhood the frequency of mumps is moderate in preschool life, but thereafter there seems to be an increase which culminates in a marked hump at age 10. Then the curve points rather sharply downwards, until at about age 18 there is another small

Table 9. Percentage Annual Risk of Getting Mumps at Different Ages and Calculated Cumulative Risk in Per Cent up to a Given Age.

Age in years	Group[1]				
	I	II	III	IV	Total
	Annual risk, per cent				
0— 4	0.1	0.4	0.2	0.2	0.1
5— 9	1.5	2.9	1.8	3.4	1.9
10—14	4.7	7.4	4.4	6.4	5.1
15—19	4.7	2.6	3.3	1.7	4.2
	Calculated cumulative risk, per cent				
5	0.5	2.0	1.0	1.0	0.5
10	7.7	15.4	9.6	16.7	9.6
15	27.4	42.5	27.8	40.2	30.4
20	43.0	49.6	39.0	45.1	43.9

hump. Other authors' curves are quite similar. As mentioned earlier, COLLINS, for example, found that mumps has its maximum frequency much later than most other "childrens' diseases," which usually have their highest frequency before school age, while mumps occurs most frequently during school age. CANDEL et al. found the same age distribution in a series of questionnaires completed by conscripts. I found in my first series two distinct humps, one at age 8 and one at age 13.

Since it seems as though mumps very often is caught from school contacts, where one goes to school—in a city or in the country-should be more important than the environment at birth. The environment at the age when one usually catches mumps should in other words be the most important factor. In city schools with their greater number of pupils—and therefore more numerous contacts—the risk of the pupils' contracting mumps would seem to be much greater than in country schools. This should be brought out to the best advantage by comparing the "unmixed" groups, viz. those who were born and schooled in cities, and those who were born and schooled in the country. These groups of our series have been so compared in table 9 and fig. 3. It will be seen that the frequency of mumps apparently is much greater before, but even more so during school age in the city boys, whose curve exhibits a very accentuated in-

[1] As regards the groups I—IV see table 8, page 49.

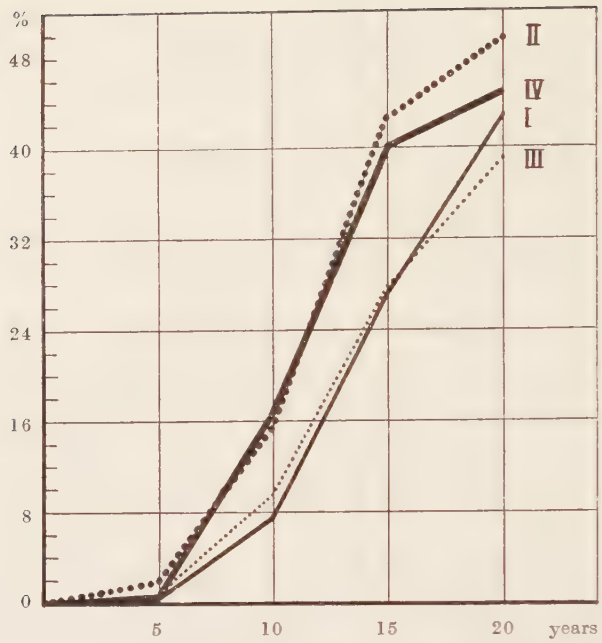


Fig. 3. Calculated cumulative risk of getting mumps in per cent up to a given age in the groups I—IV. (See table 9 page 51.)

crease at age 10. The frequency is low after age 12–14. The frequency is very low in country boys before and during the first years of school age. The latter also admittedly show an increasing tendency at about age 10, but the increase is much lower.

In the Swedish population under military age (20–21 years) the risk of getting mumps is greatest at age 10–11. This tendency is most accentuated in the urban population in which 30 per cent of all cases of mumps affect that very age group. About 2 3 of all city boys in whom mumps occurred before military age had the disease before age 12. Consequently at least 1 3 of all city boys have had it before puberty. Only about 15 per cent of the country boys had suffered from mumps before age 12. In the latter group the frequency remained practically constant from age 10–11 up to age 19. A not insignificant proportion of the country boys were infected with mumps during or after puberty.

SEX DISTRIBUTION

In order to investigate whether the incidence of mumps during childhood is the same in both sexes, or whether it is more prevalent

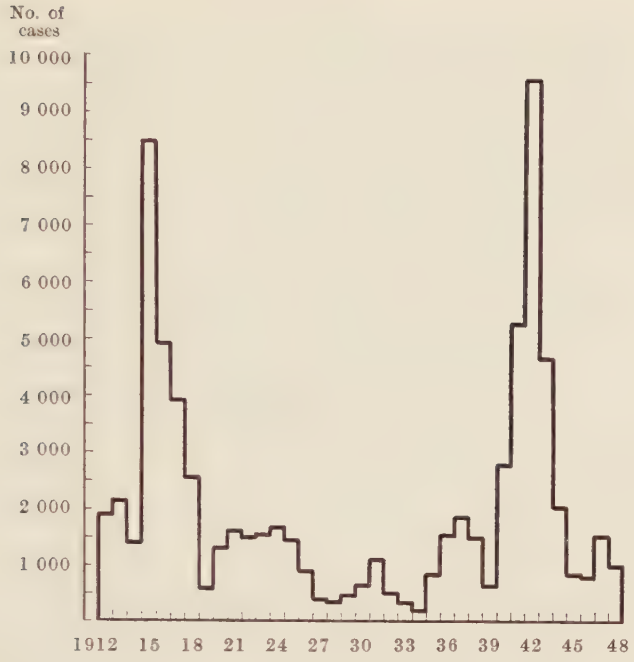


Fig. 4. Yearly number of cases of mumps in the Swedish Army during the period 1912—1948.

in one of them, I studied the sex distribution among the cases of mumps that occurred in one school year at the elementary school at Boden, Sweden. Among 76 cases 41 affected boys and 35 girls, i.e. respectively 53.9 and 46.1 per cent. The mean error for 50 per cent would be 5.7. In other words the discrepancy from 50 per cent shown by the series lies well within the limits of random variation.

INCIDENCE OF MUMPS DURING MILITARY SERVICE (FIRST TERM)

It is well known that military service not seldom raises the frequency of infectious diseases, such as we generally call trivial infections or childrens' diseases. Fig. 4 reveals the number of cases of mumps in the Swedish Army from 1912 to 1948. It appears that in some years the number of cases was much greater than in others. It is impossible to decide, though, whether this is due to variations in the frequency of mumps or in the number of men on service: as mentioned in the chapter on Statistical Material, the number of serving men is a military secret. It is nevertheless possible very

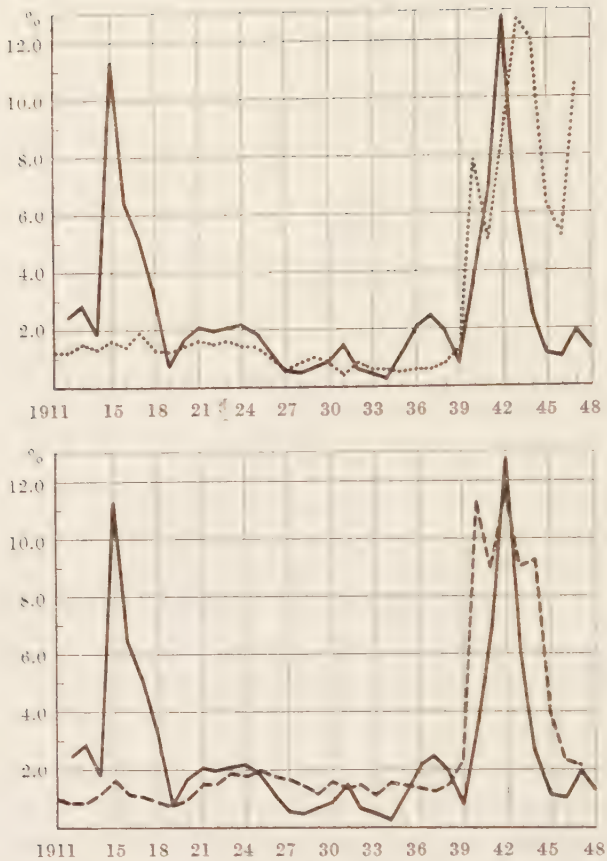


Fig. 5. Annual frequency of mental aberrations (dotted line) and leg fractures (broken line) compared with the annual frequency of mumps as percentages of total number of cases during the period 1912–1948.

approximately to estimate personnel variations by examining variations in the frequency of certain diseases. A disorder must be selected whose relative frequency would be unlikely to vary much during the period under consideration. The curves in fig. 5 represent the annual frequencies of leg fractures, mental aberrations, and mumps, being given as percentages of the total number of cases during the period. If the same number were called up each year, the annual percentages should not vary very much. However, the diagram reveals that there was a moderate increase towards the end of World War I and a more marked one during World War II. By comparing the curves it appears that the incidence of mumps rose markedly

about 1915, the increase being much greater than for other diseases. There cannot be any doubt that severe epidemics of mumps then occurred. In other years as well the mumps curve shows variations that are not parallelled by the other curves, which latter agree fairly well. It might thus be justified to speak of epidemics of mumps in 1931 and 1937, whereas the greater incidence during World War II does not seem to exceed what could be expected.

Those conscripts who commenced their military service 1945 and had completed questionnaires were, as mentioned previously, followed up 1945–1946, the object being to compare the susceptibility of those who claimed to have had mumps and the susceptibility of those who denied having had mumps.

Out of 7930 conscripts who completed questionnaires 299 or 3.8 per cent came down with mumps, which is a minimum figure as a few patients might have escaped being registered as cases of that disorder. For some reason, moreover, a number of the 7930 conscripts would have been given leave from military service and therefore would not have been exposed for an equally long period to the risk of getting mumps. It is far more significant, however, that no case of mumps was uncovered at some of the examined regiments, which implies that the conscripts in question were not exposed to the risk of being infected during their military service. At two regiments (I 6 and I 17) there were no cases of mumps, while 10 cases or less occurred at 5 regiments (2 cases at I 15, 5 at I 11, 7 at A 3, and 10 each at I 7 and I 21). Table 10 shows the frequency in per cent of mumps in the groups that, respectively, had had mumps, had not had mumps, and could not remember having had mumps. When the military service was over 3897 or 49.1 per cent of the conscripts had undergone mumps.

As mentioned previously about 19 per cent of the conscripts in my first series were infected with mumps during their military service. While on service 16 per cent of one of the regiments in my second series caught mumps, and at another about 15 per cent, and as just mentioned there was otherwise no accumulation of cases. To compare with this we may cite from the Review of Literature that RADIN among 18 000 men in a U. S. training camp within 3 months found 32 per cent diseased with mumps, MACGUINNESS & GALL 10–19 per cent in various companies in a training camp, SELSØ 7.5–28.7 per cent at different regiments, and LEINEBERG 25–30 per cent.

Table. 10. Mumps Occurring in Military Service, Distributed According to Previous Mumps.

Earlier mumps	Queried conscripts		Mumps during military service	
	No.	Per cent	No.	Per cent
"Yes"	3 628	45.8	30	0.83
"No"	3 658	46.1	252	6.89
"Don't know"	644	8.1	17	2.64
Total	7 930	100.0	299	3.77

INCIDENCE OF MUMPS IN CONSCRIPTS WHO PREVIOUSLY HAVE HAD THE DISEASE

Of the 3628 conscripts who reported having had mumps when they reported for duty 65 or 1.8 per cent put down that they had suffered from the disease more than once. Among the 299 who were infected with mumps while on service 30 or about 10 per cent on reporting for duty stated that they already had gone through the disease. This is revealed in table 10, which also shows that among those who had not had mumps before 6.9 per cent were infected. so were only 0.8 per cent of those with previous mumps, while 2.6 per cent of those who were uncertain caught the disease. Let it be remembered that the statement whether or not the person concerned had had mumps was made on reporting for duty, i.e. long before he was infected. In other words, if it were possible to distribute the "don't know" group on the other two groups, the difference would probably increase somewhat. In any case the figures suggest that the risk of any one person being infected in an epidemic is about 8 times greater if he has stated that he has not had mumps than if he has made the opposite claim. It is dangerous to make definite statements on the matter. For, as mentioned previously, the information that anybody has had or has not had mumps cannot be considered absolutely reliable. However, since all one has to go on is the person's own statement, the figures given above should be useful in practice.

It is evident from the Review of Literature that opinions vary quite a lot concerning the frequency of mumps after a first attack. Authors who impose the strict requirement that the same physician

Table 11. Cases of Mumps in Per Cent of Corresponding Figures for "All Diseases" in the Years 1912—1948.

Year	No, of "all diseases"	Mumps		Year	No. of "all diseases"	Mumps	
		No.	in per cent of "all diseases"			No.	in per cent of "all diseases"
1912	39 910	1 919	4.8	1931	38 709	1 129	2.9
1913	37 689	2 172	5.8	1932	34 421	525	1.5
1914	57 746	1 429	2.5	1933	26 667	363	1.4
1915	98 412	8 532	8.7	1934	30 771	224	0.7
1916	68 297	4 948	7.2	1935	32 825	878	2.7
1917	73 362	3 949	5.4	1936	35 791	1 556	4.3
1918	91 304	2 576	2.8	1937	40 634	1 885	4.6
1919	35 196	605	1.7	1938	42 613	1 528	3.6
1920	53 295	1 315	2.5	1939	72 413	658	0.9
1921	52 103	1 624	3.1	1940	224 678	2 805	1.2
1922	61 721	1 516	2.5	1941	224 499	5 377	2.4
1923	54 652	1 568	2.9	1942	228 081	9 676	4.2
1924	56 913	1 695	3.0	1943	221 804	4 720	2.1
1925	57 476	1 454	2.5	1944	199 406	2 059	1.0
1926	51 982	918	1.8	1945	88 370	879	1.0
1927	44 024	419	1.0	1946	73 561	828	1.1
1928	38 136	367	1.0	1947	64 802	1 549	2.5
1929	37 929	497	1.3	1948	48 966	1 016	2.0
1930	35 718	658	1.8				

must have examined the patient on all the occasions naturally obtain minimum figures, particularly since it is impossible thus to follow a considerable number of persons for any length of time. Moutier found in such a series 9 recurrences in 600 patients, the attacks being less than a year apart. Leineberg, who used a method similar to mine, stated that 5.3–8 per cent of those that previously had claimed they already had had mumps again were infected while on military service. These figures indicated that in his series the persons who had not had mumps before ran a 7 times greater risk of getting the disease than those who had been so infected previously.

MUMPS AS A MILITARY DISEASE

Being congregated so that they can infect each other, men are more likely to get mumps whilst on military service than at any other time. Hence it is understandable that mumps plays a con-

spicuous role in military medicine. A glance at table 11 will reveal the situation with respect to Swedish Forces during World War I (1915 and 1916) and World War II (1942). It will be seen that in the former years mumps constituted respectively 7 and 9 per cent of all cases of disease. Also in the U. S. Army the disease held a prominent position during World War I. On the subject SINCLAIR (1922) stated: "In terms of sick wastage, and measured by the number of days lost from military service on account of sickness, mumps was the most important disease in the American Expeditionary Forces (France)." During World War II the disease apparently was less important. According to LEINEBERG (1945 b), 10 215 cases corresponding to 200 000 lost service days, occurred among Finnish recruits during the period 1941–1942; and in some training establishments 25–30 per cent of the men got mumps. It is remarkable that the greatest accumulation of cases occurred in the second or third year of war or, respectively, preparedness for war, at which time prevailing conditions made it highly important to keep as large forces as possible fit for service. This is a significant point in view of future preventive measures against mumps.

From the below discussion on the reduction in working capacity through mumps it will be seen that the duration of treatment is long compared to most other diseases incident to military conditions. Relatively more training and service time is therefore lost than might be expected from the figure for mumps in per cent of all diseases. It is on the contrary very rare to see any permanent service disability following mumps.

INFLUENCE OF MUMPS ON EFFECTIVENESS

Basing my calculations on 536 hospital diaries from 6 different regiments, I have previously evaluated the mean number of treatment days for patients with mumps at regimental hospitals. The total number of days was 7656, which averages 14.3 per patient. Moreover, I have analyzed quarterly (monthly) sickness reports for 1942 from a large number of military units, some of them field units. These reports included 2053 cases of mumps with altogether 22 719 days of treatment, i.e. a mean of 11.1 days per patient. It was possible also to determine the mean hospitalization period for 17 patients from 2 units, the mean number of days being 13.5.

The total number of days in hospital (sick quarters) for these

2606 patients with mumps was 30 605, which is equivalent to a mean of 11.7 days per patient. It will be seen that the cases occurring in the 1942 series materially affect the mean. Most of these cases occurred at field units, where the registration probably was less satisfactory, and therefore the figure might have been a bit unreliable. The annual reports provide a little information that is relevant in this connection. FLODÉN, for example, stated that in an epidemic 1912 70 patients were hospitalized for 1014 days, the mean being 14.5 days.

In order to evaluate the number of service days that are lost through convalescence or partly inefficient work from the time of discharge from hospital to full resumption of duties, I have studied the sick cards for 180 conscripts from 4 troop units who were treated for mumps 1945–1946. For these men the mean duration of convalescence—including sick leave, light duties such as indoor and outdoor fatigue duty with important restrictions on heavy work (sick group I according to current terminology), etc.—was 2.2 days. The mean training (service) time lost has therefore been put at 14 days. As mentioned earlier this figure must be considered approximate. It may be compared with SINCLAIR's figure, 16.8, for the mean number of days lost per patient with mumps in the U. S. Army in World War I. For an epidemic of mumps in a U. S. training camp with 500 patients, part of whom were treated with chemotherapeuticals and convalescent serum, HAEREM (1943) reported a mean treatment duration of 15.8 days.

The number of service days days lost through mumps for the period 1912–1948 and the percentage due to mumps of the total loss of service days are entered in table 12. Fig. 6 represents the number of sick days in mumps per 100 000 service days, and fig. 7 the number of sick days in mumps as a percentage of the number of sick days in all diseases. Evidently the importance of mumps as a cause of lost service days varies quite considerably. As a rule, however, its share exceeds 4 per cent of the total service time lost through disease. Now and then about 8–10 per cent of all lost service time is due to mumps, i.e. nearly 1/10 of all sick days are caused by mumps certain years.

Although all such evaluations must be considered rather unsatisfactory, I have attempted to estimate the economic consequences of mumps. It has been calculated that a conscript who did his first term of military service in 1948 cost the Swedish Govern-

Table 12. Service Days Lost in Mumps and in Per Cent of Corresponding Figures for "All Diseases" in the Years 1912—1948.

Year	Sick days of mumps			Year	Sick days of mumps		
	No.	per 100 000 service days	per cent of all sick days		No.	per 100 000 service days	per cent of all sick days
1912	26 866	237	7.7	1931	15 806	210	5.2
1913	30 408	269	9.1	1932	7 350	98	2.8
1914	20 006	106	4.2	1933	5 082	80	2.5
1915	119 448	447	13.5	1934	3 136	42	1.4
1916	69 272	339	9.8	1935	12 292	163	5.1
1917	55 286	294	7.7	1936	21 784	286	7.8
1918	36 064	253	4.3	1937	26 390	334	8.2
1919	8 470	102	2.3	1938	21 392	243	5.8
1920	18 410	164	3.6	1939	9 212	76	1.7
1921	22 736	182	4.7	1940	39 270	81	2.1
1922	21 224	158	3.5	1941	74 718	153	4.2
1923	21 952	171	4.5	1942	135 464	226	6.1
1924	23 730	184	4.6	1943	66 080	115	3.0
1925	20 356	167	4.0	1944	28 826	54	1.4
1926	12 852	114	2.8	1945	12 306	54	1.3
1927	58 660	60	1.6	1946	11 592	81	1.8
1928	5 138	63	1.7	1947	21 686	159	4.0
1929	6 958	90	2.3	1948	14 224	158	3.9
1930	9 212	122	3.5				

ment 7.44 kronor per service day.[1] The costs per day of 2nd term military service were much higher, probably about 10.00 kronor. If so, the incidence of mumps in military personnel during 1942 cost the Government at least 1 354 640.00 kronor.

None of the methods adopted in this work of estimating the importance of a disease is fully satisfactory. Direct registration of the number of cases naturally has a limited value, unless the number of military personnel and the number of service days are the same from year to year, which by no means is the case. Nor does the ratio between the number of cases of mumps and the number of service days lost in mumps, on the one hand, and the number of men per year or the annual number of service days, on the other provide a complete picture as to the importance of the disease, but it does supply some indication. A glance at the diagrams reveals

[1] For this information I am indepted to Lieutenant Colonel Per Odensjö.

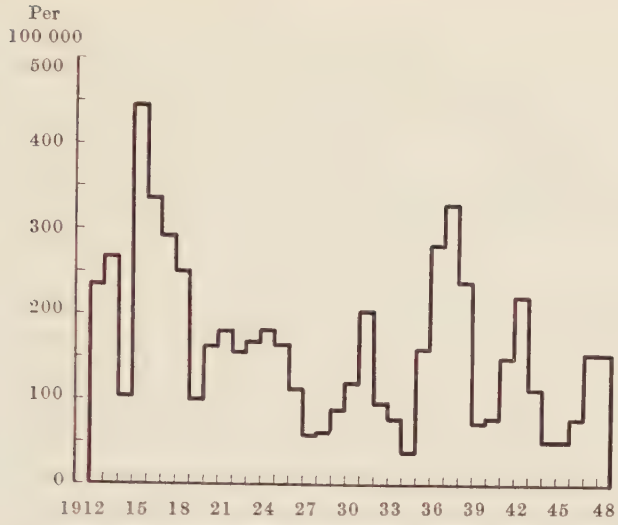


Fig. 6. Yearly number of days lost because of mumps per 100,000 service days for conscripts in the Swedish Army during the period 1912—1948.

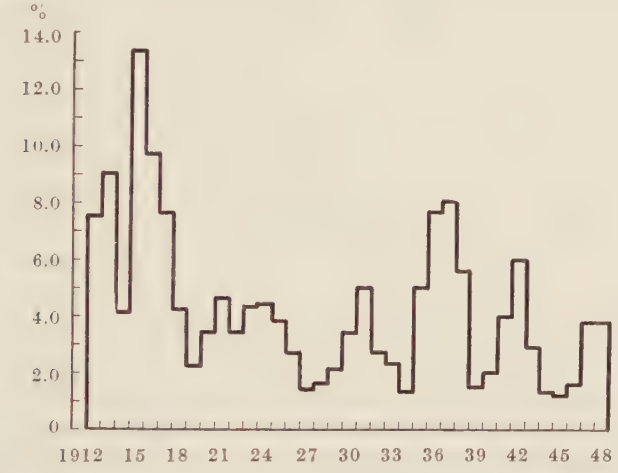


Fig. 7. Yearly number of days lost because of mumps in per cent of all days lost because of sickness in the Swedish Army during the period 1912—1948.

that the curves look different if one registers the cases of mumps in absolute numbers, or the days lost in mumps per 100 000 service days, or the sick days in mumps as a percentage of the sick days in all diseases. Since it influences their susceptibility the age of the men on service is a highly important factor. The frequency per man and year should have been lower during the World War II emergency as a comparatively larger number of age classes were called to the colours.

PART II

THE PROBLEMS OF MUMPS ORCHITIS

3

CHARACTER OF THE CASES INVESTIGATED

To get some idea of the frequency of all orchitis and of bilateral orchitis I have perused 1631 hospital diaries from 10 troop units for the years 1919–1930 and 258 diaries from 8 troop units for the years 1945–1946 as well as hospital records of 453 cases of mumps that have occurred at troop units under my own medical supervision

The notes in the first lot of 1631 hospital diaries were often insufficient and it is evident that other sites of mumps than the parotid glands sometimes were not entered on the cards. It is particularly likely that mild cases of orchitis often were missed. Consequently the frequencies of orchitis as computed from these records must be regarded as minimum figures. However. the same thing does not apply to my own figures, for my cases were examined with a special view to getting statistics over the various sites of mumps.

In order to study the consequences of mumps orchitis, I have analyzed a large number of records from Swedish troop units for the years 1919–1937. With solitary exceptions only records for conscripts aged about 20 years are included in the present investigation. The study refers especially to *bilateral* orchitis. Nearly all sets of annual records from troop units with more than 10 cases of mumps during the year were studied in so far as they were available. In some instances the records were unobtainable for various reasons. at the military units, and in other cases considerable difficulties were met with on account of the then inadequate space facilities at the Royal War Archives. The mumps records from garrison hospitals were utilized. It is impossible exactly to state the number of diaries studied, but a matter of about 10 000 records of mumps cases have been gone through. The large majority of these records were useless, however, because they merely give the diagnosis of

mumps. But in many cases the temperature curve offered a means of assuming as highly probable that mumps had been present not only in the parotids but also at other sites, e.g. in the form of orchitis. Only such diaries were used as contain an unambiguous diagnosis as to the type of orchitis or with some statement that plainly tells whether the orchitis was unilateral or bilateral. For part of the series it is possible to give the number of cases in which it is uncertain whether the orchitis involved one or both testicles. Thus, out of 1301 cases of mumps from 7 troop units during the years 1919–1930 it is uncertain whether the orchitis was unilateral or bilateral in 34 cases. The same is the case of 17 out of 258 mumps cases at 8 military units during the years 1945–1946. Therefore, in 2.6 per cent of the cases it was not possible to determine from the data on the hospital records whether the orchitis was unilateral or bilateral. Although the basic material is so extensive and the frequency of bilateral orchitis not negligible, I was able to find only 98 hospital cards that were suitable for a follow-up study. I have attempted to supplement the series by adding the cases of bilateral mumps orchitis from the larger epidemic hospitals, but I was able to obtain only 2 cases from the hospital for epidemic diseases at Stockholm and 3 cases from the same institution in Gothenburg. It was, thus, extremely hard to assemble a representative series.

In order to obtain a control series, one of the persons with the next higher or lower conscript (draft) number was selected for each case of mumps. By so doing I was able to obtain for each case of mumps a control person of the same age, from the same district and environment and with approximately the same type of upbringing. The name and address of the two persons with identity numbers above and below that of the person with mumps were obtained from the Central Conscript Bureau, or from other authorities with personnel records. Questionnaires were sent out to all these persons; the one being included in the control series who replied first, provided he could not remember having had mumps. A very few controls had undergone mumps after puberty, but so far as they knew they had not had orchitis. Sometimes it was necessary to pass by up to 10 identity numbers before names and addresses could be obtained. In solitary cases the control was substituted during the investigation, because the original control could not be found but someone else who had replied to the questionnaire could be. However, the identity number did not always belong to

a control of the same age. This applies chiefly to persons who had taken employment in the army: they were formerly given an identity number when they left the army and, therefore, those with the next number were often several years younger. Sometimes, consequently, the controls were selected on the basis of data from church records. However, this was impossible in 11 cases. In 10 cases the age difference is at most 4 years, but that should not matter much when the subjects are 35–50 years old. One age difference was as high as 9 years.

To get an idea of the impact on marriage frequency and fertility of *unilateral* mumps orchitis similar questionnaires were sent to 116 patients and as many controls. Data concerning quite a number of these had to be obtained from church registrars. Full information was obtained about 61 who had undergone mumps orchitis and about 43 controls.

Questionnaires were similarly sent to those conscripts in service 1942–1943 who then had come down with mumps with *bilateral* orchitis. At that time they were 20–22 and 7–8 years have now passed since they became ill. I have personally examined and treated some of them. 37 of these persons and 32 controls answered the questions.

The obtained data was analyzed with a view to calculating the marriage and sterility frequency in men who at age 20 or thereabouts had undergone unilateral or bilateral orchitis. Some of the patients did not answer the questionnaire, so the necessary information was obtained from church registers. A few others had died, but provided at least 10 years had passed from their military service to their death the figures were included in the computations of marriage and sterility frequency.

The addresses were utilized also to make a secondary investigation concerning the consequences of bilateral orchitis. It comprised sexual history, anthropological examination, hormone tests, and spermiogram. It proved extremely difficult to cover completely this programme for all the patients. In several cases letters and requests to send specimens went unanswered, both before and after I visited the subject who then did not refuse to participate in the investigation. Others gave data on civil status and sterility, but refused categorically to be examined when I visited them. Sometimes it was impossible to contact the subject despite several visits. The map in fig. 8 reveals the geographical distribution of the test persons who,

Fig. 8. Geographical distribution of the persons who gave their sex histories and were examined.

■ = married men who have had bilateral mumps orchitis
□ = controls to them
● = single men who have had bilateral mumps orchitis
○ = controls to them

when visited, told their sexual history and permitted themselves to be examined. For 3 of these persons only the sexual history was obtained: after being questioned they refused an examination. It would be impractical to reproduce the Northern half of Sweden since only 15 persons, 8 having had mumps and 7 controls, lived there.

Every attempt was naturally made to get a maximum number of "perfect pairs" consisting of an examined test person and a corresponding control. This aim was realized in 51 cases. Tables 13 and 14 show the number of test persons who were completely examined, partially examined, not visited or not encountered, and deceased. Some of those who were not contacted were visited on repeated occasions. For a few of the test persons it was impossible to obtain

Table 13. Examined Cases of Bilateral Mumps Orchitis.

Group	Married	Single	Total
1. Cases with examined controls	32	19	51
2. Cases without examined controls	20	5	25
3. Partly examined cases with examined controls	2	—	2
4. Partly examined cases without examined controls	2	—	2
5. Refused examination	2	5	7
6. Dead	2	1	3
7. Not visited or not found	13	—	13
Total	73	30	103

Table 14. Examined Controls to Cases of Bilateral Mumps Orchitis.

Group	Controls to		Total
	Married	Single	
Paired with examined cases	33	18	51
Examined controls to non-examined cases	5	—	5
Examined controls to partly examined cases	2	—	2
Total	40	18	58

the latest address. Others did not reply to repeated questionnaires and lived so remotely that it was not considered worth the expense to visit them: a person who left the questionnaires unanswered was thought more likely to refuse examination.

The number of persons who supplied a sperm sample and urine for hormone analysis and other relevant information will be given together with the results.

Among those who 1942–1943 had bilateral mumps orchitis at age 20 or thereabout 14 were examined. So were 3 controls. 8 of the former gave a sperm sample: 7 of these 8 supplied urine specimens for hormone analysis.

Unfortunately it was not possible to carry out testicular biopsies, which would have been valuable in view of the relationship (Olesen, 1948) between testicular size and spermiogenesis. Being not so young, these persons were not interested in having their testicles biopsied.

4

ORCHITIS AND TESTICULAR ATROPHY DUE TO MUMPS IN CONSCRIPTS

FREQUENCY OF ORCHITIS DUE TO MUMPS IN CONSCRIPTS

As mentioned previously I have slightly augmented the series that was published in 1948. The series was assembled from a large number of military units in different parts of Sweden and it embraces 27 years (1919–1946). It should consequently be fairly well suited to provide an estimate of the risk for, respectively, unilateral and bilateral orchitis in the course of mumps in conscripts, particularly recruits at about age 20, and in enlisted personnel at about the same age. It should be possible also to conclude from the figures whether the frequency of orchitis has changed in any way during the period concerned. The mumps frequency was admittedly the very reason why some of the troop units were selected, but not so for the orchitis frequency.

It appears from table 15 that 20 per cent of those who got mumps during military service were affected with orchitis. The disease being bilateral in 10 per cent of these cases, it follows that bilateral orchitis occurred in 2 per cent of all the persons who got mumps. It should be noticed that this series exhibits no variation in the frequency of orchitis from 1919–1946.

I myself have carefully examined 125 cases of epidemic mumps. In 30 of these cases the former disease was followed by orchitis, i.e. in 24 ± 3.8 per cent. Among the latter 30 cases there were 6 or 20 ± 7.3 per cent of bilateral orchitis. Hence the remaining 24 were unilateral. A simple mathematical operation shows that the frequency of bilateral orchitis in the series of 125 patients with mumps was 4.8 ± 1.9 per cent. If there is no interrelationship between right and left testicle, i.e. if involvement of one or both testicles happens at random, the frequency of bilateral orchitis in the above series should have been about 1.5 per cent. My series comprising 2342 cases of mumps (cf. table 15) should on a similar basis show about 1 per cent of bilateral orchitis. Table 15 reveals that the actual frequency was 2 per cent and that the figure varied remarkably little in the 3 subgroups. The figures from the two series just mentioned consequently differ slightly, which in the main probably

Table 15. Frequency of Orchitis.

No. of regiments (records studied)	Cases of parotitis epidemica = N	Orchitis		Bilateral orchitis		
		No.	in per cent of N	No.	in per cent of	
					the whole no. of orchitis	N
10 (1919—1930)	1 631	325	19.9	33	10.2	2.0
3 (1942—1944)	453	86	19.0	9	10.5	2.0
8 (1945—1946)	258	52	20.2	5	9.6	1.9
Total	2 342	463	19.8	47	10.2	2.0

is due to random variation and is caused by the smallness of one of the series. As previously mentioned, however, in about 2.6 per cent of the cases the hospital diaries provided no indication whether the orchitis was unilateral or bilateral. The frequency of bilateral orchitis was probably about 3 per cent. Bilateral orchitis thus seems to have occurred in 3–5 per cent of patients with mumps, which agrees quite well with the figures published by other authors (see table 5).

As a matter of fact it is probably rather surprising that bilateral orchitis is not more common. If one gets orchitis on one side, the risk should be very great of getting orchitis on the other side as well, but that does not seem to be the case.

METHOD OF COMPUTING THE TESTICULAR VOLUME

The size of the testicles was measured as follows. The testicle's length from pole to pole, breadth and thickness, as well as the scrotal duplicature were measured with sliding-calipers. Initially, however, only one measurement was taken in the horizontal plane. While being measured the testicle was held between the forefinger and thumb of one hand, slightly stretching the scrotal skin over polse or margins before the caliper jaws were applied with very light pressure. I naturally endeavoured to apply the caliper jaws with equal, and the lightest possible, pressure to the testicle while taking all measurements. The scrotal duplicature was measured on both the right and the left side. These measurements are very simple to perform.

except when the testes are very tender or the scrotum small and firm with thick skin and the testes small or easily slide up towards or into the inguinal canals. Complications also arise in hydrocele, when it may be very difficult to measure exactly the distance between the testicular margins.

If it is not deemed adequate to denote the size of testicles by giving the length of axes or comparing them with other objects, e.g. plums, hazelnuts, etc., it will be necessary to deduce af ormula whereby the axial measurements can be used to compute the volume.

The formula for the volume of a cylinder is base times height. Suppose that the diameter of the base is d, then the formula will be

$$\frac{\pi d^2}{4} \times h,$$

where h is the height and d the diameter. The formula for an ellipsoid of revolution is

$$\frac{4}{3} \times \frac{\pi d^2}{4} \times \frac{h}{2}.$$

If it is desirable now to use the latter formula to compute the testicular volume, two sources of error must be kept in mind. The first thing is that calipered measurements tend to be slightly too small, because the testicle is being compressed when the measurements are taken. The second thing is that the testicle is not certainly an ellipsoid of revolution. The organ is more likely a cylinder provided with rounded ends.

With the object in view of studying the relation between the testicular volume calculated from the axial lengths as measured through the scrotal skin and the actual volume of the testicles, I have carried out some investigations on testes post mortem. It turned out that the volumes obtained by means of the above formula were too small. Such being the case I have developed an empiric formula based on the assumption that the testicular volume is $k \times abc$, where a, b and c are the lengths of the testicle's axes and k is a constant. Based on 20 pairs of testicles $k = 0.71 \pm 0.04$ and the standard deviation for $k = 0.17$. In 40 observations the lowest k value was 0.37 (calculated value 0.20), and the highest 1.08 (calculated value 1.22). Consequently the error of method is quite large.

When the formula $0.71 \times abc$ is employed to obtain the testicular volume, the probability is about 1/3 that the true value will deviate

at least 25 per cent from the calculated value and 1/20 that the discrepancy is at least 50 per cent. This includes all sources of error in measurement and calculation. In addition to the above-mentioned sources of error, where the error due to compression of the testis possibly is smaller for living persons than for corpse owing to the greater turgor of living tissue, the effect of the epididymis on the measurements must be taken into consideration. For a normal epididymis cannot be so exactly palpated that its effect on the measurements can be neglected. Owing to its localization the epididymidis will influence the interpolar measurement and the horizontal measurement in the median plane. It seems impossible, however, to decide when the epididymis is included in the measurement. Corpus epididymidis probably does not always lie so exactly along the posterior testicular margin that it constantly will affect the measurement taken in that plane. In all probability, therefore, corpus epididymidis generally influences the median plane measurements and sometimes those in the frontal plane. Hence, considerable errors must be expected in attempts exactly to compute the testicular volume in living men. These sources of error are naturally more important when the testicles are small. Exact measurements are often very difficult to take in such cases. However, this is not important in the case of adults with very small testes: in such cases it is certain that the organs must be considerably atrophied.

As mentioned previously, only one of the axes in the horizontal plane was measured in some of the men. In these cases the volume was computed under the assumption that the breadth and the thickness were equal (i.e. $c = b$). In all cases when both axes were measured the difference between them was at most 7 mm. as a rule it was 2–3 mm, and often there was no difference.

The testicular volume was evaluated in 78 men who had suffered from mumps orchitis and in 58 controls. Both testes were palpated in all members of the two groups. Sometimes the scrotum was small and firm, which made palpation and measurement difficult. So did the fact that in some persons the testes were very mobile and easily slipped into the inguinal canal.

TESTICULAR VOLUME IN "NORMALS"

I shall first discuss the results obtained from the controls who, as mentioned above, were 58 in number. Unilateral testicular atrophy

was exhibited by 4 of the controls, i.e. about 7 per cent. These cases were included in calculations of the mean testicular volume. The mean volume per pair of testicles was 40.3 $\pm$ 1.6 ml with a standard deviation of 11.8 ml. This is the value for "normal" men, provided that they are not required to have two normal testicles but only that they are selected at random. Should the possession of two "normal" testicles be a required criterion, then it will be necessary to reject persons with unilateral atrophy of the testicles. This applies to 2 of the controls in my series. The 2 others were rejected with rather more hesitation, both of them exhibiting definite but moderate right-sided atrophy as well as left testicles with volumes below average.

I shall now give some details on these 4 cases. All the persons had children. During childhood 2 of them had experienced a trauma, and the left testicle had been small as long as they could remember. The third had noticed that lately the right testicle had grown smaller, and at the time of examination it was soft and tender. The other testicle exhibited nothing pathological except that it was small. The case history gave no clue to the commencing atrophy. The fourth person had never noticed any testicular reduction. He had undergone some severe infections (epidemic influenza associated with pneumonia at age 27 and rheumatic fever at age 30). His wife had experienced two pregnancies, the first of which was normal, while the second ended in eclampsia and stillborn child. At the time of his wife's confinements the husband was 32 and 38 years old (when examined by me he was 46 like his wife). He told me that conception was immediate when the children were wanted. Otherwise coitus interruptus had been used successfully as a contraceptive method. Two sperm tests revealed oligospermia. In other respects the medical examinations of the man showed nothing pathological. The rejected persons had a total testicular volume of 19.4, 21.0, 21.5, and 33.1 ml.

The above 4 cases having been excluded, the mean testicular volume in 54 "normal" men with "normal" testicles was 41.6 $\pm$ 1.5 ml with a standard deviation (σ) of 11.2. The values were scattered about the mean in such a manner that 40 cases lay within the limits of $M \pm 1\sigma$, another 11 lay within the limits of $M \pm 2\sigma$. No value was lower than $M - 2\sigma$, while in 3 cases the total volume exceeded $M + 2\sigma$. The highest volume was 82.9 ml and the smallest 21.6 ml. Considering the mean of 41.6 ml and the standard deviation, all the values, as mentioned, exceeded 19.1 ml ($M - 2\sigma$). Judging by

Table 16. Orchitis and Control Series Classified According to Total Testicular Volume.

Testicular volume, ml	Orchitis cases	Control cases
< 10	11	—
10—19	19	—
20—29	19	5
30—39	12	24
40—49	9	16
50—59	4	6
60—69	1	2
70—79	1	—
80—89	—	1
Total	76	54
Mean and standard error	26.6 ± 1.7	41.6 ± 1.5
Standard deviation.....	15.0	11.2

my normal series, I consequently consider myself justified in putting 20 ml as the lower limit for the total volume per pair of "normal" testicles.

The series was also used to see if the *right* and the *left* testicle exhibit any difference in size. The right testicle was bigger than the left in 30 persons, in 11 the left was bigger than the right, while in 13 the two testicles were as big. The mean for the right testicle was 21.9 ml and for the left 19.6 ml, which yields a significant difference of 2.3 ± 0.7 ml.

FREQUENCY OF TESTICULAR ATROPHY AFTER MUMPS ORCHITIS

The total mean volume per testicle pair in 76 men who had experienced mumps orchitis was 26.6 ± 1.7 ml with the comparatively large standard deviation of 15 ml. In table 16 the series has been classified according to total testicular volume. The table reveals that in 11 cases the total volume was at most 10 ml and in 30 at least 20 ml. The total volume ranged from 10 to 40 ml in most cases. The table also shows the controls similarly distributed. Fig. 9 shows graphically how the two series are distributed according to testicular volume. The shape of the curves, which are remarkably skew, is largely the same, the only difference being that the mumps

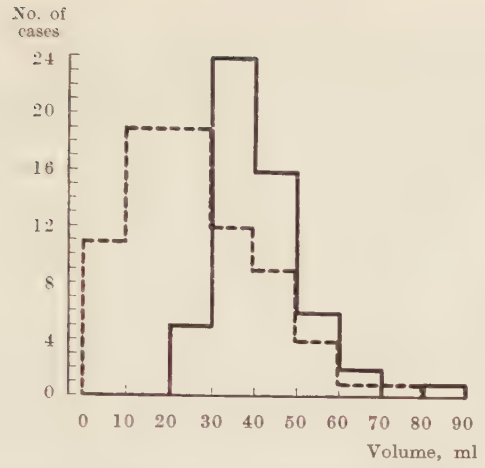


Fig. 9. The volume of testes in ml for cases who have had orchitis (broken line) and for normal cases (whole line).

orchitis series shows somewhat lower values. The difference between the control mean, 41.6 $\pm$ 1.5, and the mumps orchitis mean, 26.6 $\pm$ 1.7, is 15.0 $\pm$ 2.3 and is statistically significant.

In comparing the volumes of right and left testicle the standard deviation for the individual differences was found to be 5.1 ml in 54 controls and as much as 10.6 ml in 76 cases of mumps orchitis. The high standard deviation for the orchitis series indicates that the series probably contained a comparatively large number of unilateral atrophies. The question then arises how one can tell when one is confronted by a case of unilateral atrophy. Disregarding the already mentioned and relatively negligible volume difference between right and left testis, one can say that the individual differences are scattered about the mean zero. The standard deviation is 5 ml, which implies that a minimum difference of 10 ml ($= 2\sigma$) between right and left testis is present in only 5 per cent of the "normal" cases. All cases of orchitis with a difference greater than the latter value may on good grounds be termed abnormal, unilateral atrophies. If the 76 cases of orchitis are considered in this light, one can sort out 30 cases with a total testicular volume of less than 20 ml, in other words 39.5 $\pm$ 5.6 per cent of the bilateral cases of orchitis exhibited bilateral atrophy. In 12 cases the volume of the left testicle was at least 10 ml less than the right, and in 8 cases the right testicle had a volume at least 10 ml less than the left. According to these principles, therefore, unilateral atrophy of the testicles was present

in 20 or 26.3 ± 5.1 per cent of the bilateral cases of orchitis. If the unilateral and bilateral cases of testicular atrophy are added, the result is that 50 persons exhibited testicular atrophy out of 76 men who had experienced bilateral mumps orchitis. The corresponding percentage is 65.8 ± 5.4 per cent.

5

MARRIAGE FREQUENCY AND FERTILITY AFTER MUMPS ORCHITIS

I have attempted to evaluate to what extent the results of mumps orchitis possibly might influence the *marriage rate*. If mumps orchitis can give rise to infertility in men, which often has been demonstrated, the risk of pregnancy in extramarital relations vanishes for those who have become sterile. Basing his facts on official Swedish statistics, DAHLBERG (1947) has shown that a very large percentage of married women with children, especially in young age groups, gave birth 7 months or less after matrimony. As could be expected the percentage drops with age, but at age 20—25 it is 25—30 per cent. DAHLBERG declared that the figures give "a strong impression that an expected child is the reason for many marriages." If such is the case, extramarital relations when the male is sterile should lead to marriage later or not at all.

As I have mentioned elsewhere my series comprised 103 men who have had mumps orchitis, and controls to all but one of these. Three of the persons in the mumps orchitis series proved to be dead when the questionnaires were returned by relatives or church registrars. One of the latter had been married for 14 years from age 26 till age 40, at which time he committed suicide. According to the church registrar he had no children. One had been married for 4 ½ years between his 38th and 44th year, when he was killed in an accident without having had children, according to the church registrar. One was according to the same authority unmarried and childless when he was killed in an accident at age 38. It may be mentioned that the control to the latter also was killed in an accident at age 45: he was married and had one child. These persons were included in the series, because the data on them was

so complete as to be quite satisfactory. Four persons from the mumps orchitis series and 3 controls did not return any questionnaires, the only available information having been supplied by church registrars. Since the discussion is based on the assumption that fertility may affect the matrimonial rate, it would naturally be interesting to know if those of the latter persons who were single (one from the orchitis series and one control) have any children. The information about men from church registrars concerning illegitimate children seems to be unreliable, since in certain cases such children are apparently registered only on the mother. They were nevertheless included as the investigation deals with civil status and not fertility.

Four persons were excluded because of unreliable data. They reported not having had, having had unilateral, or not knowing if they had experienced mumps orchitis, despite the fact that their hospital diaries were unequivocal. The controls to these persons, as well as the person from the mumps orchitis series for whom there was no control, were likewise excluded. There now remained 98 comparable pairs.

Among the 98 persons in the series of bilateral mumps orchitis 30, i.e. 30.6 $\pm$ 4.7 per cent, were single. So were 13 or 13.3 $\pm$ 3.4 per cent of their controls. The difference amounts to 17.3 $\pm$ 5.8 per cent and is therefore statistically significant. When the civil status was registered the subjects were between 31 and 51 years old, the mean age being 42.2 years. In this connection it should be noted that at age 40 about 20 per cent of the entire male population are single.

The investigation could be restricted to those whom I visited personally and obtained case histories from, where the information thus is more reliable. Such a restricted series would, however, to some extent be selected, for the completely examined pairs comprised only 35 out of 68 married and 19 out of 30 single persons who had experienced bilateral mumps orchitis. Among the controls 47 are married against 7 who are single, while 19 out of 54 in the orchitis series are single. Thus, 35.2 $\pm$ 6.5 per cent of the persons in the latter series of bilateral mumps orchitis are single, while 13.0 $\pm$ 4.6 per cent of the controls are single. Being 22.2 $\pm$ 8.0 per cent, the difference is not statistically significant.

The same analysis was applied to the series of men with *unilateral* mumps orchitis and their controls. Among 61 of the former 11 are

single, i.e. 18.0 ± 4.9 per cent, while 8 out of 43 controls are single, i.e. 18.6 ± 5.9 per cent. In this case, therefore, there was no appreciable difference in marriage frequency.

Among the men in my series who had *bilateral* mumps orchitis in 1942 as many as 20 out of 37 are single, and so are 17 out of 32 controls. The series is too small to allow of any definite conclusions being drawn, but it seems as though below age 30, when only about 50 per cent of the men are married, the lowering of the marriage frequency by experienced mumps orchitis had not yet made itself felt.

The series of test persons used to determine the marriage frequency, i.e. 98 men who have experienced bilateral mumps orchitis and as many controls, were employed also for studying the *reproductivity*. Not only children born in or out of wedlock but also aborted pregnancies were included. The latter happened to 6 persons in the bilateral orchitis series and to 3 of the controls. In only one of the cases, that of a control, was it miscarriage only. The remaining 8 instances were characterized by full-term pregnancy as well. However, data on miscarriages is probably more unreliable than data on children, particularly when only the church registrar's information is available, but also when the person himself replied.

Here, naturally, another element of uncertainty comes into play, viz., the desire to keep secret the existence of an illegitimate child. As I pointed out in the chapter on Statistical Material, I throughout tried to get data direct from the patient, also with respect to illegitimate children who often seem to be registered only on the mother. Thus, in an investigation like this it is not possible to control whether a person is trying to suppress the existence of an illegitimate child. What one can do is to note the number of single men who claim to have children. Among 43 single men 2 or 4.7 per cent admitted having children. One of these persons came from the bilateral orchitis series and one was a control. Thus, among 13 single controls 1 had an illegitimate child, whereas the same applied to only 1 out of 30 single men from the bilateral orchitis series. It does not seem justified, however, from this fact to draw the conclusion that persons who have had mumps orchitis run a smaller risk of getting illegitimate children than controls.

In estimating the fertility due regard was paid to the civil status and, for married persons, to the age of man and wife and to the duration of the marriage. Most of the men had passed the age when

one usually marries and begets children. One must consider in connection with the effect on fertility of marriage duration whether both man and wife are young enough to conceive. It should be remembered that no general upper age limit can be set for the male's ability to conceive and that women seldom become pregnant after age 45, although in exceptional cases the latter limit may shift upwards by at most 5 years. Here the term marriage duration consequently does not refer to the social duration of the marriage but to its biological duration from the fertility viewpoint. For practical reasons, however, the marriages were considered to have started on the wedding day and not when sexual intercourse with risk for conception first took place. The duration of a marriage was therefore counted from the wedding year to the year it was dissolved or to the year when the wife had her 45th birthday. Exact dates were not available in some cases, but the duration of the marriage from the aspects just mentioned could be ascertained for 66 men from the series of bilateral mumps orchitis and for 81 controls. In the former case the mean duration was 12.5 years and in the latter 13.6 years. On the wedding day the mean age of the men from the series of bilateral mumps orchitis was 29.3 years and of the controls 28.7 years, the respective figures for the wives being 25.8 and 26.0 years. It will be seen that there was nothing remarkable about either the marrying age or the marriage duration from a fertility aspect.

Among the 98 men in the series of bilateral mumps orchitis 47 were fertile, i.e. 48.0 $\pm$ 5.1 per cent, while 81 were fertile out of the same number of controls, viz. 82.7 $\pm$ 3.8 per cent. The difference amounts to 34.7 $\pm$ 6.3 per cent and is evidently statistically significant. Two of the fertile men were single, one who had sustained bilateral mumps orchitis and one control. Since, as previously mentioned, most of the men had passed ordinary marrying and conceiving age and most married couples want one or more children —and illegitimate children contrarywise are unwanted or at any rate probably are unwanted—it was interesting to compare the fertility of married men from the series of bilateral mumps orchitis with the fertility of married controls. 67.6 $\pm$ 5.7 per cent of the former and 94.1 $\pm$ 2.6 per cent of the latter were fertile, which yields a statistically significant difference of 26.5 $\pm$ 6.3 per cent (cf. table 17). If only complete pairs of married men from both groups are compared, it will be found that there were 60 such pairs. In these pairs 41 of the married persons from the series of bilateral

Table 17. Marriage Rate and Fertility in Orchitis and Control Series.

Group	Men with earlier bilateral orchitis	Control cases	Difference
Total number = N	98	98	
of which married = n, No.	68	85	
» » » , %	69.4 ± 4.7	86.7 ± 3.4	17.3 ± 5.8
Fertile men, No.	47	81	
» » , % of N	48.0 ± 5.1	82.7 ± 3.8	34.7 ± 6.3
Fertile married men, No.	46	80	
» » » , % of n	67.6 ± 5.7	94.1 ± 2.6	26.5 ± 6.3
No. of conceptions	112	205	
Conceptions:			
per man	1.1 ± 0.2	2.1 ± 0.1	1.0 ± 0.2
» married man	1.6 ± 0.2	2.4 ± 0.1	0.8 ± 0.2
» married fertile man	2.4 ± 0.2	2.5 ± 0.2	0.1 ± 0.2
Average duration of marriage, years	12.5	13.6	

mumps orchitis were fertile, i.e. 68.3 ± 6.0 per cent, and so were 57 of the controls, or 95 ± 2.8 per cent. The difference, 26.7 ± 6.6 per cent, is statistically significant.

It will be seen from table 17 that the men from the series of bilateral mumps orchitis averaged just over 1 child, whereas the mean for each control was just over 2 children. This difference in fertility is statistically significant. If we consider only the married men—which naturally must be studied separately as relatively more men from the bilateral orchitis series were single—we also find a statistically significant difference that admittedly is smaller and averages just under 1 child per married couple. There is no difference, on the other hand, if regard is paid only to the fertile. If a man who has experienced bilateral mumps orchitis is at all fertile, he seems to have the same chances of getting many children as other men.

The series was also used to study the time that elapsed between the marriage and the birth of the first child. The below tabulation reveals that in this respect there is practically no difference between marriages where the man has had bilateral mumps orchitis and marriages where one partner is a control person.

First child born	Mumps orchitis series		Controls	
	No.	%	No.	%
Before the wedding	6	15	7	13
Within 7 months	14	36	15	29
7–12 months	3	8	6	12
2nd year	7	18	11	21
3rd–4th year	7	18	10	19
5th year or later	2	5	3	6
Totals	39	100	52	100

Based on the combined series 46.2 per cent of the firstborn children were born before or within 7 months after the wedding.

6

SPERMIOGENESIS

The spermiogenesis was studied in all those subjects who could be talked into giving a sperm sample, which it seems a lot of men are unwilling to provide. This even applies to the male of a barren couple when the reason for the childlessness is to be found. The same man, who willingly sees his wife submitting herself to quite tedious and bothersome examinations to find out if there is anything wrong with her fertility, often balks at going to the slight trouble and moderate inconvenience of giving a sperm sample. It is proportionately more difficult, obviously, to get sperm samples from men who have no immediate interest in knowing whether or not they are fertile. Moreover, it is impossible to obtain samples from men who never, or not for many years, have experienced coitus and are not in the habit of masturbating. It is rather surprising actually that such a relatively large proportion of the subjects did give sperm samples. Some of them had a personal reason for having the investigation made, but only a few were of an age when it is usual to want children. Of course, in some cases other reasons might have contributed to their wanting to know whether they were fertile.

However, the giving of a sperm sample does involve a little bother. Particularly for such as have been used to intercourse without contraceptives for many years, it may be troublesome. The first attempt

is not seldom a failure, as a rule because all the ejaculate does not get into the sampling bottle. In such cases the defective sample is often sent in, and then there will be endless discussions before a new sample is submitted. Time and again reminder upon reminder had to be sent before a satisfactory sample arrived. On my visits to the patients I made every attempt to procure fresh samples. Sampling bottles had been despatched in advance and the time for the visit had been set. For obvious reasons a fresh sample was not always available when I arrived. And there was very seldom time to revisit the subject on a later occasion in order to procure a fresh sample. It follows that most of the samples were not fresh when the motility was estimated, so the fertility was often assessed rather vaguely. Only a few samples were examined in detail by myself. The ambulatory nature of the investigation raised insurmountable obstacles in the way of itinerant sperm studies. Most of the tests were made at Laboratory III, the Women's Clinic (Docent E. Nordlander), the Caroline Hospital Stockholm. Whenever I made detail sperm studies myself a control sample was sent to the same laboratory. A few sperm analyses were made at the Women's Clinic of the Sahlgren Hospital, Gothenburg.

Attempts were made to obtain repeated samples from each subject, but it was often more difficult to get the second than the first. Three or more samples were made available in a few instances.

The sperm sampling and analysis procedures as well as the nomenclature used to designate the results were those proposed by Nordlander (1948). The donor of the sample was unknown to the laboratory, nor did the laboratory technician know whether it came from a mumps orchitis patient or from a control. Condom samples were sometimes accepted because the person concerned would otherwise not have given any sample, it being easier to give a condom sample. Besides, it is quite possible to estimate serious fertility impairment, such as aspermia and cryptospermia, in condom samples. And when the samples have to be posted, as in this case, condom samples are more likely to include all the ejaculated matter. The condom technique often affects the motility and sometimes the morphology of the sample in such a way that no definite conclusions can be drawn regarding anything but volume ejaculated and sperm count.

Of those men who had undergone bilateral mumps orchitis whom I had occasion to examine 42 submitted sperm samples. More than

Table 18. Cases of Aspermia (or Cryptospermia) among Men after Bilateral Mumps Orchitis.

Case No.	Age in years	No. of conceptions	Age at last conception	Testicular volume ml	Sperm assay		
					Date	Volume, ml	Remarks
	Married.						
2	47	0	—	8.5	1.8 –48	3.8	Moderate no. of nucleated sperm cells
7	47	2	24	24.6	17.9 –48	3.2	Centrifugate: 0 sperms found
19	45	0	—	11.3	14.6 –48	3.6	Cryptospermia: 7 sperms in 200 squares (magn. × 945)
20	45	0	—	7.4	4.7 –48	6.5	Cryptospermia: 10 sperms in 200 squares
					5.12–50	5	» 6 » » 200 »
23	48	0	—	24.1	8.6 –48		Immediate assay: 0 sperms
					9.11–48	0.3	Centrifugate: 0 sperms
24	41	0	—	8.6	5.7 –48	4.0	» 0 »
	Single.						
O 9	43	0	—	8.3	15.8 –48	9.1	Centrifugate: 1 sperm head
					18.7 –48	1.0	Incomplete: 0 sperms
» 13	39	0	—	4.8	13.9 –48	7.5	Centrifugate: 0 sperms Moderate no. of nucleated sperm cells
» 21	35	0	—	6.7	4.8 –49	2.5	Centrifugate: 0 sperms
					30.3 –50	3.3	Cryptospermia: 2 sperms in 200 squares
» 25	45	0	—	7.1	16.8 –49	2.7	Centrifugate: 0 sperms
					1.10–49	2.5	» 0 sperms in 1 300 squares

one sample was given by 16 of the latter. Of the single men 11 gave samples and 7 would not be persuaded because they had not for many years or ever had coitus. The remaining single and all the married men who did not give samples refused to explain their refusal. Among the examined controls 10 sent in samples.

Great caution must, as noted previously, be exercised in interpreting the results. Some conclusions can nevertheless be drawn, particularly from samples showing aspermia or cryptospermia. The results of semen analyses in 10 men who had undergone bilateral mumps orchitis are entered in table 18. Undoubtedly all of them were sterile when I examined them.

Normal morphological findings were shown by sperm samples from 2 single and 8 married men who had undergone bilateral mumps orchitis. The same was true for 6 of the 10 examined controls (table 19).

[1] Not investigated.

Table 19. Cases with Normal Morphology in Sperm Sample.

Case No.	Age in years	No. of conceptions	Age at last conception	Testicular volume ml	Sperm assay							Remarks
					Date	Volume, ml	Count		Per cent abnormal sperm heads	Motility		
							mill./ per ml	total mill.		per cent	hours before assay	
					Men after bilateral mumps orchitis.							
	Married.											
5	47	3	43	9.6	21.9 –48	3.2	82	262	15	27	25	—
15	45	2	39	50.6	14.2 –50	3.2	174	557	12.5	0	34	—
31	33	5	32	46.7	15.8 –48	4.2	132	554	14	25	25	—
					18.8 –50	4.5	137	616	13	20	25	
41	35	0	—	34.6	30.6 –49	3.5	58	203				slight teratospermia
					31.8 –49	3.0	181	543	7.5	90	1	
53	49	0		45.7	12.12–50	4.9	192	940	31.5	35	25	
60	38	2	38	21.5	25.8 –49	14.6	99	1 445	13	35	43	—
63	49	1	24	18.5	7.12–49	1.5	82	123	15	8	26	—
69	36	2	34	31.9	18.12–49	3.1	78	242	10	15	12	—
	Single.											
O 16	36	—	—	26.8	6.7 –49	10.0	46	460	32	0	69	slight teratospermia
					30.7 –49	11.1	63	699	26	75	1	
61	41	1	32	44.9	16.8 –49	2.6	119	309	18	85	5	—
					Control persons.							
K 42	39	1	39	31.1	28.8 –49	3.6	113	407	27.5	15	36	slight teratospermia miscarriage
» 61	42	1	40	33.1	16.8 –49	1.9	63	120	25	83	3	—
KO 7	44	0	—	49.7	5.7 –48	4.8	118	566	15	0	28	—
» 9	44	2	43	35.2	12.12–48	2.5	363	908	27	0	35	slight tera-tospermia[1]
										70	1	
» 22	34	2	32	25.6	31.7 –49	3.7	113.5	420	8	20	37	—
					27.8 –50							
» 24	38	2	46	44.4	23.9 –49	4.8	146	701	18	0	70	—

The situation was less clear for those persons whose spermiograms suggested impaired fertility, viz. 26 men of whom 22 had undergone mumps orchitis and 4 controls. Among these men 9 were regarded as having gravely reduced fertility (table 20). In all of them the total number of sperms was less than 15 millions. In most cases the percentage of abnormal sperm heads was raised and the motility, where is could be estimated, was in most cases unsatisfactory. In

[1] 2. ejaculation in 24 hours.

Table 20. Cases with Oligospermia, Suggesting Severely Impaired Fertility among Men after Bilateral Mumps Orchitis.

Case No.	Age in years	No. of conceptions	Age at last conception	Testicular volume ml	Sperm assay							Remarks
					Date	Volume, ml	Count: mill. per ml	Count: total mill.	Per cent abnormal sperm heads	Motility: per cent	Motility: hours before assay	
Married.												
1	49	2	30	15.8	1.8 –48	2.0	0.56			74	1	[1]
					18.11–48	3.6	1.8	6.5	23	0	28	[2]
9	48	0	—	15.1	24.4 –49	2.3	3.9	9.0	35	20	23	
11	47	1	23	12.9	30.7 –48					15	1	
					12.8 –48	5.6	2.2	12.3	53.5	9	12	
17	38	0	—	24.1	4.7 –48	0.5	5.7	2.9	46	0	<24	
32	36	2	29	24.7	12.1 –50	1.0	11	11	43	15	3	
44	40	1	30	14.8	8.9 –49	3.3	1.6	5.3	31	25	1	
59	43	0		17.6	18.8 –49	3.7	1.5	5.6	10	0	32	
Single.												
22	38	0	—	14.0	31.7 –49	9.3	1.15	10.7	33	50	1	
										3	43	
24	37	0	—	9.4	20.7 –49	0.6	1.9	1.1				[3]
					5.9 –49	1						[1]

only 3 of these cases were repeated analyses possible, and both samples were defective in one of them. Accordingly, great care is required in drawing conclusions. Whenever two samples were available, however, the results agreed rather well. With the above reservations, these men were very likely infertile when they gave their samples. Four of them had children and apparently, therefore, they were fertile before them. I shall discuss these cases later.

In 17 men, 13 who had undergone mumps orchitis and 4 controls, the spermiogram suggested slightly impaired fertility (table 21). The oligospermia in 3 of the 4 controls seemed to be due to shortness of the interval from the preceding ejaculation. Of the 10 married men in this mumps orchitis group 9 had children and must therefore have been fertile before even if it is doubtful whether they

[1] incomplete.

[2] 8.5 per cent nucleated sperm cells.

[3] 2. ejaculation in 24 hours, centrifugate: 5 sperms per square.

Table 21. Cases with Oligospermia, Suggesting Slightly Impaired Fertility.

Case No.	Age in years	No. of conceptions	Age at last conception	Testicular volume ml	Sperm assay: Date	Volume, ml	Count: mill./ per ml	Count: total mill.	Per cent abnormal sperm heads	Motility: per cent	Motility: hours before assay	Remarks
					Men after bilateral mumps orchitis.							
					Married.							
14	39	1	35	63.3	4.2 –50 16.1 –51	6.9 3.6	44 46	304 166	35 25	12 0	60 35	—
18	37	1	34	26.8	11.12–49	0.6	66	40	10.5	0	55	
27	37	2	35	12.8	12.12–48	9.2	10	92	15	*	40	* slight for 3 sperms
38	44	5	34	26.1	10.12–49 17.9 –50	0.5 3.5	157 42	79 147	6.5 42	0 0	70 35	
40	39	1	29	37.4	18.8 –49	4.2	21	88	33	39 *	5 50	* slight
42	39	4	37	18	21.8 –49	2.8	33	92	23.5	80 0	3 41	2 miscarriages
48	41	1	30	12.6	28.7 –50 21.8 –50	1.0 4.5	34 36.5	34 164	10.5 10	60 20	3 18	
56	35	0	—	22.6	13.10–49 17.4 –50	5.5 7.5	6 4.6	33 35	36 17.5	10 5	26 ?	
58	48	1	26	14.8	9.9 –49	10.0	11.5	115	18	25	24	
64	36	3	27	46	14.12–49	2.1	35.5	75	16.5			incomplete
					Single.							
O 3	39	0	—	37.6	8.7 –49	4.7	23.5	110	34	0	24	condom, specimen
					22.9 –49	2.2	84	185	16.5	61 0	1 24	
					15.6 –50	2.0	36	72	21	12	15	incomplete
					4.8 –50	3.1	28	87	54	0	9	
» 8	50	0	—	19.9	8.8 –50	4.5	10	45		0	28	
» 26	33	0	—	35.2	20.7 –49 2.9 –49	3.5 3.3	27.8 18	97 59	19	0 51 0	20 3 35	incomplete
					Control persons.							
K 13	49	2	41	21.5	1.8 –49 7.12–49	4.5 3.7	20 24	90 89	23.5 14.5	9 10	15 15	
» 57	33	8	32	55.9	30.7 –49	4.0	19	76	20.5	0	39	2. ejaculation[1]
KO16	36	2	36	47.2	31.7 –49	1.5	11	16	17	90	3	» [1]
» 21	34	4	33	82.9	6.9 –49	3.7	32	98	48	5	27	» [1]

[1] in 24 hours. [2] in 72 hours.

Table 22. Fecundity and Sperm Assay.

Group			Aspermia and cryptospermia	Oligospermia		Normal spermiogram	Total
				severe	moderate		
Men after bilateral mumps orchitis	Married	Fertile	1	4	9	6	20
		Childless	5	3	1	2	11
	Single	Fertile	—	—		1	1
		Childless	4	2	3	1	10
Controls	Married	Fertile	—	—	4	5	9
		Childless	—	—	—	1	1
	Single	Fertile	—	—	—	—	—
		Childless	—	—	—	—	—
		Total	10	9	17	16	52

were fertile when they sent in their samples. More than one sample was analyzed, and the results agreed well, in 5 of these cases.

The fecundity has been related to the spermiograms in table 22. It will be seen that the two factors agree fairly well.

The spermiograms warrant very limited conclusions only. One can never be absolutely sure that samples obtained at coitus interruptus are quantitative. Single analyses, moreover, must always be cautiously interpreted. Whenever a second sample was sent in after some time the result must of course be more accurate. Repeated analyses agreed well in some cases (nos. 11, 31, O 16, K 13). Some cases among those which were interpreted as oligospermia showed quite a large discrepancy between two samples with regard to ejaculate volume, total number of spermatozoa, and morphological findings. However, the tendency was on the whole the same in the repeated samples. In addition to the unreliability of the results, it must be borne in mind that sperm counts and sperm morphology only in exceptional cases can prove that a person is fertile or infertile. Nor can comparisons with the fecundity provide conclusive proof, because the subject need not necessarily be the father of the child or children. The paternity is especially doubtful when there is only one child which was conceived out of wedlock or before the subject's marriage.

7

HORMONE EXCRETION

As I found that a large number of the mumps orchitis patients still remained single at a time when a much greater proportion of their controls were married, the question arose, whether hormonal investigations would have any practical value, and if so what tests should be made. Urinary gonadotropin assay seemed to have primary importance in these persons, but estimates of the production of active androgens and 17-ketosteroids appeared to be valuable also. The secretion of oestrogens, on the other hand, was not studied because the fluorometric method was then not yet developed and the biological method was too laborious and expensive and not sensitive enough.

I aimed at getting data from as many of my test persons (and controls) as possible on gonadotropic hormone. production of active androgens by the cock's comb test, and 17-ketosteroids by Zimmermann's reaction.

I therefore requested all the examined persons, both those who had undergone mumps orchitis and the controls. to submit urine samples. When they were visited some of the patients proclaimed their willingness to cooperate but later they would not trouble themselves to send in samples. Mostly no explanation was given and the specimen containers just came back despite repeated reminders. A few persons gave urine samples but would not submit to a medical examination (cases no. 3 and O 20). or I was unable to find an opportunity to examine them (cases no. 71. K 43 and KO 23). I attempted—mostly unsuccessfully—to obtain more than one sample.

COLLECTION AND TREATMENT OF URINE SAMPLES

The number of urine analyses and their distribution on married and single mumps orchitis patients and controls are shown in the below tabulation.

Each test and control person was sent a 2 litre bottle containing some ml of ethanol-chloroform. By means of accompanying directions they were instructed carefully to collect and send in all urine excreted over a 24-hour period.

Urine Analysis	Mumps Orchitis				Controls	
	Married	Single	Total	Multiple samples	No.	Multiple samples
FSH	31	16	47	1	10	0
Active androgens (cock's comb test	40	19	59	19	25	5
17-ketosteroids	40	20	60	19	26	3

The bottles were immediately returned and as a rule they reached the laboratory within 4 days where they were treated at once. This was impossible in some cases. If so they were stored at room temperature until treatment could take place. HAMBURGER has shown that the values for active androgens and 17-ketosteroids are not reduced even if the urine is stored at room temperature for several months (personal communication). This holds good even if preservatives are not added. I also analyzed samples that had been stored for a considerable time. partly to secure duplicate determinations, partly because second samples were unobtainable in some cases. Gonadotropin being rendered inactive by storage at room temperature, gonadotropin titres were not taken in "old" samples.

The donor of the sample was not known to the laboratory, nor did the worker know whether the sample came from a man who had undergone mumps orchitis or from a control.

The analytical procedure with regard to active androgens and extraction of gonadotropic hormone was laid down after consultation with Doctor Christian Hamburger, M.D., the first substances being determined wholly according to his method (cf. HAMBURGER & HALVORSEN, 1942; HAMBURGER, 1948, HAMBURGER & RASCH, 1948). The gonadotropin titration method was selected in collaboration with Doctor Egon Diczfalusy, M.D. Since I did some of the work myself and the analytical procedures were completed for active androgens and 17-ketosteroids at the Hormone Diagnostic Department of the State Serum Institute (Copenhagen) and for FSH titres at the Hormone Laboratory of the Caroline Hospital (Stockholm), I shall here discuss the procedures in some detail.

Half the 24-hour volume of the carefully stirred urine was taken and treated by the tannic acid precipitation method. The precipitate was washed in alcohol-ether and stored as dry powder for later FSH assay. Two portions, each corresponding to about 1/50 of the 24-hour urine, were hydrolyzed and extracted with ether,

and the dried ether extracts were kept for later active-androgen and 17-ketosteroid titration.

The dried extracts—which are storable for months—were then sent to the respective laboratories for final hormone analysis. A few 17-ketosteroid titrations, however, were performed at the Hormone Laboratory of the Caroline Hospital. In such cases all the work was carried out there so that the preliminaries were not done in my laboratory.

METHOD USED FOR MEASURING THE AMOUNT OF GONADOTROPIC HORMONE AND A BRIEF DISCUSSION ON OTHER METHODS

I shall not here give a complete review of the available methods of determining gonadotropic hormones (ICSH and FSH). For such data the reader is referred to the survey by Li & Evans (Pincus & Thimann, 1948).

Gonadotropic hormones can be demonstrated only by biological means. No chemico-colorimetric methods are available. Before the biological assay the gonadotropins must be extracted from the urine, since the gonadotropin concentration in urine often is so small as not to be demonstrable. The most usual methods are the alcohol precipitation method which originally was used by Zondek (1931), the tannic acid precipitation method (Levin & Tyndale, 1936, Thomsen & Pedersen-Bjergaard, 1936), the ammonium sulphate method (Heller & Heller, 1939), and adsorption methods.

The tannic acid precipitation method, the standard method at the State Serum Institute, was adopted for the present study. The dried tannic acid extract was tested for follicle-stimulating hormone (FSH) on mice, according to a method which is based on determination of the increase in uterine weight (Klinefelter, Albright, & Griswold, 1943). According to Smith, Albright, & Dodge (1942–43), the mouse is more sensitive as a test animal than the rat, and as a test organ the uterus is preferable to the ovary. The Klinefelter method, which nowadays is generally considered the most valuable test method we have for endocrine diagnosis, is based on the principle that in immature female mice the injected FSH, together with the minute quantities of interstitial cell stimulating hormone in the mouse pituitary body, give rise to a production of ovarial oestrogens. The latter in turn act on the uterus which responds by a marked increase in weight. The greatest advantage of

the method is that it permits determination of FSH in amounts as small as 6.5, or even 3, m.u.u. (mouse uterine units). One m.u.u. is defined as the amount of hormone that will give rise to an increase in the weight of the uterus by 100–150 per cent. The procedure is as follows: Female mice, 20–22 days old and weighing between 6 and 8 g, are each given during three consecutive days altogether 5 × 0.5 ml a solution of the extract in physiological saline, and on the 4th day the uterus is weighed. Three animals are used for each titre level. According to researches conducted at the Hormone Laboratory of the Caroline Hospital (Diczfalusy & Westman, personal communication), the uterus weight in the control animals does not exceed 3.5 mg. The reaction is not considered positive unless the uterus in the test animal weighs more than 7 mg after the experiment. As a rule, however, the uterus then weighs considerably more, in the majority of cases so much more that the reaction offers no interpretative difficulties.

Klinefelter & coworkers rather than by tannic acid precipitation obtain the extract by alcohol precipitation which they consider gives quantitative recovery. Loraine (1950) expressed a similar opinion. For low titre values, however, Klinefelter & coworkers use brief dialysis to reduce toxicity. The dialysis is accompanied by quite an appreciable lowering of the hormone content. Consequently the values obtained by the dialysis method cannot be compared with those obtained by the non-dialysis method. For the titre levels I have used (15–240 m.u.u.) dialysis was not at all necessary. According to Howard, Sniffen, Simmons, & Albright (1950), the normal values for men in fertile age range between 6.5 and 53 m.u.u. per day. The same criteria are adopted by the Hormone Laboratory at the Caroline Hospital. Per 24-hour urine 76 and 96 m.u.u. are regarded as raised values. It is consequently warranted to state that those of my subjects who excreted more than 120 m.u.u. in 24 hours had a pathologically increased gonadotropin production. Since I used only half the volume of 24-hour urine for FSH determination, no determinations could be made at titre level 6.5 m.u.u. It was impossible, therefore, to discriminate between cases of normal and cases of pathologically diminished FSH secretion.

Whether the Klinefelter test is an absolute measure of FSH, or perhaps of ICSH also, is a moot question (Howard & Co 1950). Unlike ICSH, which alone is capable of inducing hypertrophy of

the prostate by stimulating the production of androgens, FSH cannot alone provoke oestrogen production and thereby uterine hypertrophy. Thus, in hypophysectomized animals the FSH is ineffective unless it is contaminated by traces of ICSH, whereas the converse is not true. Both FSH and ICSH are nevertheless capable of causing uterine hypertrophy in the presence of very small amounts of the other hormone. So far as we know the male pituitary gland contains FSH is abundance but very little ICSH (Greep & Jones, 1950), and it therefore seems likely that chiefly FSH is excreted with the urine.

It lies outside the scope of this work to discuss whether the increase in weight of the uterus can be ascribed to one or both of these hormones, but the subject has been given a full treatment by Howard, Sniffen, Simmons, & Albright (1950) and Diczfalusy, Högberg, & Westman (1950). Yet I am of the definite opinion that the tested gonadotropic hormone was FSH. The possibility remains, however, that the production of ICSH also may have been changed pathologically. But so far we have no generally accepted method of determining ICSH and no normal values have been found. It is definitely known, however, that the Leydig cell function is controlled directly by ICSH. It would consequently be extremely valuable if we could determine the amount of ICSH and, thus, distinguish between normal men's secretion and that of men in whom Leydig cell damage is suspected. Unfortunately Lloyd & coworkers' (1949) hyperemia test is not sufficiently specific, while Greep & coworkers' (1941) prostate test requires hypophysectomized rats and is therefore very laborious and expensive. However, in two of Howard & coworkers' (1950) patients, Greep has shown that ICSH is excreted in the urine. At present research is going on at the Hormone Laboratory of the Caroline Hospital to develop a routine method for determination of ICSH production with the aid of non-hypophysectomized, immature, male rats. (Personal communication from Diczfalusy & Westman.)

DETERMINATION OF ACTIVE ANDROGEN PRODUCTION

Testosterone has not yet, as noted previously, been found in any organ other than the testicle, whereas active androgens, on the other hand, apparently can be produced by other organs as well, particularly the adrenals. One cannot be sure that these substances

or other hormones or hormonal metabolites—which are determined by urine analysis—are an adequate expression for substances in the blood which have a similar biological action or chemical composition. Even so, one would not know whether the amount circulating in the blood stream is proportionate to the amount produced in any given organ. It might well be that various organs produce substances having the same biological action and an extremely similar or even identical chemical composition, so that they cannot be separated by present-day analytical methods. However, a more complete picture of testicular testosterone production might be painted with recourse to a method of estimating testosterone—or its active androgenic metabolites—in the blood. Törnblom (1946b) has developed such a method. However, requiring 300 ml of blood, its usefulness is limited, at any rate for an ambulatory investigation like mine.

Two different methods were used to procure some idea of the androgens in the organism. Partly a biological method was used to assay the amount of biologically active androgens secreted into the urine, partly a colorimetric method was adopted to estimate the amount of urinary steroids with a keto group at carbon atom no 17, i.e. 17-ketosteroids, to which belong the androgens as well as other substances, e.g. oestrogens. The reaction is such, however, that oestrogens are not included in the final result. Here it should be mentioned merely that the two methods are not directly comparable. Although all 17-ketosteroids give more or less the same colorimetric results, they have highly different biological activities. According to Fraser, Forbes, Albright, Sulkowitch, & Reifenstein (1941), about 2 3 of the neutral 17-ketosteroids come from the adrenal cortex and about 1/3 from the testicles.

Androgens are present in the urine in a water soluble, biologically inactive form. Heating after acidification causes them to turn into a fat soluble, water insoluble form which is biologically inactive. However, the hydrolysis also destroys some of the androgens, thereby reducing the total amount of active androgens. Ever improving methods, which it is unnecessary here to discuss, have steadily reduced losses and augmented recovery of the active substances.

The presence of androgens is demonstrated either by the cock's comb method or by various procedures involving mammals, usually rodents. In the latter methods it is standard practice to estimate the amount of androgens in the urine, after injection into test

animals, by measuring the increase in weight of the seminal vesicles or prostate or both.

The cock's comb test has been most widely used up to the present. It involves measurement of the increase in area or weight of the cock's comb and either capons or chickens a few days old are used. After extraction of the urine and evaporation to a dry powder which is dissolved in oil, the administration takes place either by injection or by direct application to the comb with a syringe. According to Fussgänger (1934), the latter procedure is far more sensitive than an injection.

Here I shall not discuss earlier investigations, but simply refer to Hamburger, Halvorsen, & Pedersen's (1945) work. In order to obtain representative normal data, these authors analyzed urine samples from 130 normal males from 4 months to 80 years of age. With the aid of the results they then plotted a curve showing normal means. They stated also that no normal man in their series between 20 and 60 years of age showed an androgen production of less than 20 I. U. per 24 hours.

A few additional works are mentioned together with a review of the literature on secretion of 17-ketosteroids.

METHOD USED FOR MEASURING THE AMOUNT OF 17-KETOSTEROIDS AND A BRIEF DISCUSSION ON OTHER METHODS

Zimmermann (1935) published a method of determining 17-ketosteroids. However, it is Callow & coworkers (1938) to whom we are indebted for an accurate and careful elaboration of the method. This is the method, in a modification published by Hamburger (1948), that I have adopted here. Though the error of method in biological assay of active androgens is comparatively large, Callow's modification of Zimmermann's method agrees quite well, according to Dorfman (1948), with the colorimetric procedure: correlation coefficient = 0.745. Normal men and women at different age levels have been studied by several authors. Barnett, Henly, Morris & Warren (1946) summarized most papers published since 1939. The tabulation includes 149 cases aged from 17 to about 40 years which were studied at 9 different laboratories. In the different investigations the mean secretion ranged between 9.05 and 18.4 mg per 24 hours. Barnett & coworker's tabulation does not include some small series published by Talbot & Butler (1942) and Ven-

NING & KAZMIN (1946) which showed approximately the same values. Having determined 17-ketosteroids and androgens (biologically active) in 7 cases, LUFT (1943) found a fairly high correlation between the methods. In 23 men between 16 and 82 years of age he found values ranging between 14.3 and 43.1 mg per 24 hours. Additionally he observed 3 men with genital hypoplasia in whom he found somewhat lower values: 6.6–15.5 mg per 24 hours. HAMBURGER (1948) published a very lucid investigation and tabulation of the production of 17-ketosteroids in 137 normal males aged from 3 to 102 years. With the aid of the results he plotted curves for mean, maximal and minimal values. Corresponding results were obtained by KIRK (1949) in a series of 77 men between 40 and 97 years of age. Between age and 17-ketosteroid production he found a correlation coefficient of –0.50. Another review (DORFMAN, 1948) of some small series of males in the 17–40 years age group shows results similar to the investigations previously mentioned. MCGULLAGH, SCHNEIDER, BOWMAN, & SMITH (1948) estimated the production of 17-ketosteroids in 40 normal males (age not specified), finding it to vary between 4.9 and 18.4 mg (most of them between 6 and 14 mg) per 24 hours. They also assayed the androgen production in 20 normal men between 24 and 40 years old and obtained values ranging between 17 and 104.1 I. U. per 24 hours. All but 2 of the men secreted more than 20 I. U. per 24 hours. MCGULLAGH & HRUBY (1949) found a 17-ketosteroid excretion of 6–16 mg per 24 hours in 48 normal men. KENIGSBERG, PEARSON, & MCGAVACK (1949) published results from a group of 82 men between 17 and 75 years old. They found the highest secreted amounts between the 17 and 35 year age levels. The mean for 34 samples from 11 men aged 35 to 49 years was 15 mg per 24 hours with the boundary values 7 and 23 mg and a coefficient of variation of 19 per cent.

One cannot escape the fact that in recent years determinations of 17-ketosteroids have become, in parallel with FSH assays, one of the most important diagnostic methods in the entire field of endocrinology. It should be remembered, however, that the diagnostic value of total 17-ketosteroid determinations or of biological assay of excreted androgens is limited, and that large deviations from the normal values alone have diagnostic significance. It is to be hoped that future improvements of the methods of separating various 17-ketosteroid compounds will provide us with more accurate diagnostic aids.

For a fuller review of the subject the reader is referred to the discussions by CALLOW (1950) and DORFMAN (1948).

SUGGESTIONS CONCERNING THE INTERPLAY BETWEEN PITUITARY GLAND AND TESTES

This field is still full of unsolved problems, and any theory must therefore be hypothetical. With some modifications, I have largely adhered to the theories advanced by ALBRIGHT & coworkers. It is well established that androgens can be extracted from the adrenals, and that, under some pathologic conditions, these glands may secrete androgens in abundance. At present the pituitary control of the release of androgenic steroids from the adrenals is incompletely understood. Pure ACTH (adrenocorticotropic hormone) has no effect on the prostate in hypophysectomized rats (LI, 1948). Similarly, pure ICSH[1] (GREEP & co., 1942) or pure HCG (human chorionic gonadotropin), according to DICZFALUSY, HOLMGREN, & WESTMAN (1950) has no effect on the prostatic weight in hypophysectomized-gonadectomized rats. There is ample clinical evidence in favour of the view held by ALBRIGHT & coworkers, that ICSH is capable of stimulating the adrenal cortex (REIFENSTEIN, FORBES, ALBRIGHT, DONALDSON, & CAROLL, 1945; HELLER, 1948). It was suggested by HOWARD, SNIFFEN, SIMMONS, & ALBRIGHT (1950) that a stimulation of the androgen production in the adrenals perhaps would necessitate a combination of ACTH and ICSH effects. Quite recently, however, BORELL, DICZFALUSY, & WESTMAN (1951), using ACTH and ICSH combined, were unable to stimulate the ventral prostate in hypophysectomized-gonadectomized rats. Therefore, considering our present imperfect knowledge regarding the testis-adrenal relationship and the pituitary control of the androgen release from the adrenals, it seemed to me advisable to omit the adrenals from the discussion.

According to the diagram (figur 10), ICSH directly stimulates the Leydig cells to produce the male androgenic hormone (GREEP, VAN DYKE & CHOW, 1941, 1942). In addition it is effective on the germinal epithelium (SIMPSON, LI, & EVANS, 1944, 1946), but this feature is not marked on the diagram as it is impossible to exclude that it is an indirect effect of Leydig cell hormone.

[1] ICSH = LH = Prolan B (ZONDEK, 1931) = Metakentrin (COFFIN & van DYKE, 1941).

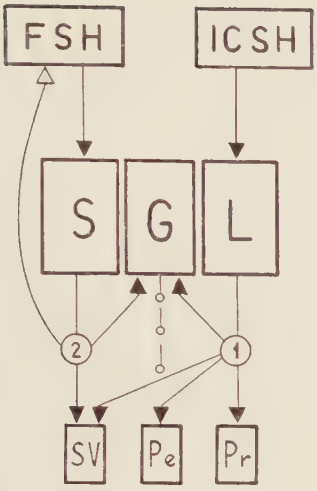


Fig 10. Schematic diagram to indicate the present authors' view of normal interrelations regulating sex function in the male (slight modifications of ALBRIGHTs scheme).

FSH	Folliclestimulating hormone of the anterior pituitary.
ICSH (= LH)	Interstitial-stimulating hormone of the anterior pituitary.
S	Sertoli cells in the testicle.
G	Germinal epithel.
L	Interstitial cells (LEYDIG) in the testicle.
SV	Seminal vesicle.
Pe	Penis.
Pr	Prostate.
——▶	Stimulating hormone.
- - - ▷	Inhibiting hormone.
—o —o —o	Sperm.
1	Male androgen hormone.
2	The second testicular hormone.

The function of the Leydig cells is to produce Leydig cell hormone, the male androgenic steroid 1. It seems to be testosterone or closely related steroids (SELYE, 1947). It controls the weight and function of the prostate, penis and seminal vesicles. This is proved by the fact that these organs degenerate following castration, while testosterone restores the normal condition in the organs. Moreover, the hormone must be capable of stimulating the germinal epithelium, since it maintains spermiogenesis in hypophysectomized rats (SIMPSON & EVANS, 1946).

FSH stimulates the spermiogenesis, even if postoperative regression of the tubuli has been allowed to take place after hypophysectomy (FEVOLD, 1944). In analogy with the effect of ICSH

on the germinative epithelium via the Leydig cells, it may be assumed that the effect of FSH is transmitted via hormone production in the Sertoli cells.

The Sertoli cells seem to possess a twofold function: partly to provide mechanical support for the germinative epithelium, partly to produce hormones. By FSH stimulation the Sertoli cells, in ALBRIGHT's opinion, produce "X" hormone. In order to show that I have no fixed attitude to the chemical nature of this hormone, I prefer to call it the second testicle hormone. Like oestrogen, the second testicular hormone is said to inhibit FSH production and stimulate the seminal vesicles by a myogenic effect (SELYE, 1947). MOTTRAM & CRAMER (1923), as noted, launched the theory that the germinal epithelium in the testicle produces a hormone which stimulates the pituitary body. MCCULLAGH & coworkers (1932, 1934) extracted from the testes a water soluble hormone which was capable of inhibiting the pituitary effects of castration. TÖRNBLOM (1942) demonstrated that the effect of castration or experimental degeneration of the tubules—pituitary hypertrophy—could be inhibited by a substance which he had extracted from testicles and which was proved biologically to tally with oestradiol. ALBRIGHT & coworkers (KLINEFELTER & coworkers, 1942; HOWARD & coworkers, 1950) studied this problem in particular. They stated that the Sertoli cells produce a hormone, »X» hormone, with an inhibiting effect on pituitary FSH production. They based their views on observation in cases of a specified syndrome and in mumps orchitis patients. Testicular biopsy in these cases revealed degeneration of the tubules at the same time as the Leydig cells apparently were intact. The production of FSH was raised, which cannot be due to impaired production of androgens. The latter statement among other things was based on the existence in mumps orchitis of normal virilization and normal production of 17-ketosteroids. However, in one of their 3 cases of mumps orchitis the secretion of 17-ketosteroids was as low as 2 mg per 24 hours. Furthermore, much larger testosterone doses are required to inhibit the production of FSH than to restore the secondary sex characteristics. Oestrogens are much more effective inhibitors of the FSH secretion.

With regard to the second testicular hormone's chemical nature, it seems most likely, in view of TÖRNBLOM's aforementioned experiments, observation in Sertoli cell tumours, etc., that it is an oestrogenic substance. However, HOWARD & coworkers suggested

that it might be Δ^5-pregnenolone. Without restoring Leydig cell or prostatic atrophy in hypophysectomized rats, this hormone beneficially affects the spermiogenesis.

Several observations indicate that the Sertoli cells are the seat of production of the second testicular hormone. Sertoli cells are the analogue to the granulous or theca cells in the ovary, and the second testicular hormone seems to be the analogue to the oestrogen produced by the latter cells. Sertoli cell tumours produce oestrogens in abundance (Greulich & Burford, 1936, and others) and, according to Huggins & Moulder (1945), they contain lipids like so many steroid-producing cells. It is supposed, therefore, that this second testicular hormone is produced by the Sertoli cells, but the less likely alternative—that it is produced by the germinal epithelium—cannot be entirely ruled out.

TESTICULAR VOLUME AND HORMONE SECRETION

Whether the testicular volume and the secretion of androgens or 17-ketosteroids, respectively, are correlated, is a factor which I have made it my business to investigate. For 78 examined men, 56 having undergone mumps orchitis and 22 being controls, there was a statistically significant moderately positive correlation between testicular volume and excretion of biologically active androgens, viz. $+ 0.35 \pm 0.11$. However, in the individual case the relation between volume of the testicle and secreted amount of androgens varied within wide limits. In one person with a testicular volume of 37 ml the cock's comb test gave the result 12 I. U. per day, while in another with a testis volume of 5 ml the secretion was 59 I. U. per day. This is not so surprising in view of the considerable sources of error that both the test methods suffer from.

Since under normal conditions the production of 17-ketosteroids largely follows the secretion of androgens, and since the error of method is much smaller for the first procedure than for the second, I have also calculated the correlation between testicular volume and production of 17-ketosteroids. Between testicular volume and production of 17-ketosteroids for 78 men, 56 having undergone mumps orchitis and 22 being controls, there existed no significant correlation (coefficient of correlation: $+ 0.15 \pm 0.11$). In some persons with large testicular volume the figures for 17-ketosteroid production were remarkably low, particularly with respect to two mumps

orchitis patients and one control with testicular volumes between 34 and 37 ml and 17-ketosteroid production between 6 and 9 mg per 24 hours.

By calculating the correlation between active androgen and 17-ketosteroid production, it was found that the two were associated by a statistically significant and moderately positive correlation (coefficient: $+ 0.43 \pm 0.09$).

Owing to the smallness of the group and the large errors of the test methods, it is of course imperative that one steps gingerly before drawing any conclusions from the correlations given above.

PRODUCTION OF GONADOTROPIC HORMONE FOLLOWING MUMPS ORCHITIS AND IN CONTROLS

Of the 47 men who had undergone mumps orchitis 10, i.e. 20 per cent, had an FSH secretion of from 15 to 30 m.u.u. per 24 hours, i.e. definitely normal values. Of the others, 9 produced less than 15 m.u.u. per 24 hours. It is impossible to tell with certainty whether in these persons the production was normal or subnormal, because tests were not made at titre levels lower than 15. All of the 10 examined controls produced less than 30 m.u.u. per 24 hours, 4 of them less than 15.

The tannic acid precipitation method is, as noted previously, probably less sensitive than the alcohol precipitation method. Consequently the values obtained ought to be minimal values. For this reason, and because of the upper limit found for the admittedly few controls, I interpret all values over 30 as possibly raised and all values over 60 as definitely raised. However, as noted previously, it should be remembered that HOWARD, ALBRIGHT & coworkers (1950) found that of 33 titrations in urine samples from normal men 17 lay between 26 and 53 m.u. per day and only 4 were higher than 53 m.u. Since these determinations were made by the dialysis method, their results must also be regarded as minimal values.

For 11 of the men in my series the values lay between 30 and 60 m.u.u. per 24 hours. Thus, for these 11 men, it is not certain whether the production actually was pathologically raised.

In 17 men who had undergone mumps orchitis, i.e. about 36 per cent, the production of gonadotropic hormone exceeded 60 m.u.u. per 24 hours. In 4 of them it was around or over 120 m.u.u. per 24 hours, an extremely high value. Thus, the production of FSH

Table 23. Cases with Gonadotropin Excretion less than 15 m.u.u./day.

Case No.	Age in years	No. of conceptions	Age at birth of last child	Urinary androgens I.U./day (cock's comb test)	Urinary 17-ketosteroids mg/day	Sperm assay	Size of testes ml	Prostate	Penis length cm
Mumps orchitis. Single									
O 2	46	0	—	15 6	4.2 6.5	not done	11	small	4.7
» 3	39	0	—	22 13	11.9 13.2	slight oligo-teratospermia	38	normal	11.5
» 20	45	0	—	31	10.4	not done	not investigated		
» 28	33	0	—	25	7.1	»	37	slight enlargement	10.2
Mumps orchitis. Married									
41	35	0	—	26 36	9.0 8.4	normal	35	normal	8.6
60	38	2	38	55 48	11.2 8.8	»	22	enlargement	9.8
63	49	1	25	5	4.3	»	19	[1]	6.7
69	36	2	34	16	6.3	»	32	normal	7.1
71	49	3	30	27	11.9	not done	not investigated		
Controls									
KO 21	34	4	32	87	11.6	slight oligo-teratospermia	83	[1]	9.6
» 24	38	2	38	16 6	6.9 6.0	normal	44	normal	8.6
K 50	32	7	32	8	9.3	not done	37	[1]	10.1
» 74	49	3	48	25	7.2	»	41	normal	9.0

was probably or perhaps significantly raised in 60 per cent and significantly raised in 36 per cent of the men I had examined who had undergone mumps orchitis.

Table 23 shows the results of hormone analysis and sperm count in the individuals who had a gonadotropin excretion of less than 15 m.u.u. per 24 hours. It should be noted that all but two, nos. O 2 and 63, in this group had normal testicular volume. The first of these cases is discussed separately in chapter 8. The findings in this

[1] Not investigated.

Table 24. Cases with Excessive Gonadotropin Excretion after Bilateral Mumps Orchitis (Married men).

Case No.	Age in years	No. of conceptions	Age at birth of last child	Urinary gonadotropin m. u. u./day	Urinary androgens I.U./day (cock's comb test)	Urinary 17-keto-steroids mg/day	Sperm assay	Size of testes ml	Prostate	Penis length cm
5	47	3	42	>120	6 22	11.0 7.7 10.5	normal	10	not investigated	10.0
19	45	0	—	>120	22	6.8 8.0	cryptospermia	11	normal	7.6
23	48	0	—	>120<240	17 11	9.0 5.9 7.7	aspermia	24	slight enlargement	6.0
32	36	2	28	about 120	8	10.5	oligo-asteno-teratospermia hypospermatia	25	not investigated	12.3

case (no. O 2) were: no potency, absent ejaculations; no beard, absent axillary hair, no hair on the trunk and extremities, scanty pubic hair; castrate skin; testes, penis and prostate small: moderate obesity. The androgen production values, as determined by the cock's comb test, were plainly low. The values for excretion of 17-ketosteroids were clearly abnormally low or on the low side of normal on the border to pathological values. It was unfortunately impossible to carry the gonadotropin titrations below 15 m.u.u., but if it had been done and FSH production values below 6 m.u.u. per 24 hours had been recorded this would have suggested impaired anterior pituitary function. Then it might either be a matter of a primary pituitary change independent of the mumps orchitis or of a pituitary lesion perhaps due to mumps orchitis. So far as I can find no such case has ever been described. It is noteworthy that the patient himself so unhesitatingly dated his distress to the year after that when he had mumps orchitis.

Four cases of very high gonadotropin production are shown in table 24. In two of the cases the total testicular volume was very small, and in the other two it was on the verge of what the normal group indicates should be considered bilateral testicular atrophy. It was difficult to measure the testicles of patient no. 23, and I am inclined to believe that the true volume was lower than the calcu-

Table 25. Cases with Moderately Raised Gonadotropin Excretion after Bilateral Mumps Orchitis.

Case No.	Age in years	No. of conceptions	Age at birth of last child	Urinary gonadotropin m. u. u./day	Urinary androgens I. U./day (cock's comb test)	Urinary 17-ketosteroids mg/day	Sperm assay	Size of testes ml	Prostate	Penis length cm
					Single					
O 5	44	0	—	>60<120	17	8.4	not done	9	normal	7.3
» 9	43	0	—	>60<120	8	6.5	aspermia	8	small	9.8
» 25	45	0	—	>30< 60 >60<120	22 111	13.3 10.4	»	7	normal	10.6
» 27	35	0	—	about 60	28 39	11.6 12.7	not done	30	»	7.7
					Married					
1	49	2	29	>60<120	30 16	10.1 8.4	excessive oligospermia	16	»	10.0
7	47	2	23	>60<120	3 5	9.0 11.5	aspermia	25	»	10.0
12	42	2	34	>60<120	13	8.5	not done	21	enlargement	10.4
14	39	1	34	>60<120	25	9.0	slight oligoteratospermia	63	normal	12.0
18	37	1	32	>60<120	20 60	12.9 12.9	hypospermatia else normal	27	[1]	9.7
20	39	0	—	about 60	16 39	12.7 18.7	cryptospermia	7	[2]	9.5
24	40	0	31	» 80	26	12.8	aspermia	9	normal	9.1
56	35	0	—	» 60	29	10.7	slight oligoteratospermia	23	»	11.3
64	36	3	—	» 60	49	19.5	slight oligospermia	46	»	9.3

lated volume. The case is described in chapter 8. The findings were: no intercourse during recent years, ejaculations rare; beard, pubic hair and hair on the trunk scanty; penis small (6 cm), androgen production low by the cock's comb test, but 17-ketosteroids showed normal, though low, values according to Zimmermann's reaction. These cases conform quite well with the 3 described by Howard, Sniffen, Simmons & Albright (1950) of high FSH production following mumps orchitis. Two of these cases demonstrate that normal spermiogenesis and fertility are compatible with quite severe

[1] Not investigated. [2] Slight enlargement.

Table 26. Cases with Normal Gonadotropin Excretion.

Case No.	Age in years	No. of conceptions	Age at birth of last child	Urinary gonadotropin m. u. u./day	Urinary androgens I. U./day (cock's comb test)	Urinary 17-ketosteroids mg/day	Sperm assay	Size of testes ml	Prostate	Penis length cm
					Mumps orchitis. Single					
O 13	39	0	—	<30	13	11.6	aspermia	5	normal	8.1
» 17	39	0	—	>15<30	46	10.7	not done	53	»	10.5
» 24	37	0	—	>15<30	8	6.6	oligospermia?	9	small	9.0
» 29	33	0	—	>15<30	14	11.1	not done	24	normal	8.0
					Mumps orchitis. Married					
11	47	1	22	>15<30	9	7.4	oligo-asteno-teratospermia	13	»	10.0
29	42	2	29	>15<30	12	6.7	not done	71	»	10.7
31	33	5	32	>15<30	42	15.6	normospermia	47	»	9.0
44	40	1	29	>15<30	12	10.5	oligo-asteno-teratospermia	15	»	9.3
54	42	0	—	>15<30	7	11.5	not done	not investigated		
59	43	0	—	>15<30	43	9.6	oligo-teratospermia	18	normal	9.3
					Controls					
KO 4	48	4	42	>15<30	21	7.9	not done	36	»	8.8
» 7	44	0	—	>15<30	46	7.4	normospermia	50	enlargement	11.8
» 9	44	2	43	about 15	78 16	8.5 9.5	»	35	»	8.9
» 23	38	3	37	>15<30	27	8.2	not done	not investigated		
» 26	33	0	—	>15<30	28	9.9	»	43	normal	9.5
K 43	44	0	—	>15<30	30	17.3	»	not investigated		

lesions to the tubules and perhaps to the Leydig cells as well. It is nevertheless surprising that spermiogenesis and fertility can remain unimpaired with such severe lesions as the hormonal investigations suggest in case 5.

The 13 individuals who showed rather a moderate increase of the gonadotropin production are collected in table 25. Among the cases 6 showed severe atrophy of both testes, in 4 cases the total testicular volume was close to the minimum for normal values, and in 3 cases the volume was normal. In 6 of the cases whose spermiogenesis was investigated it showed aspermia or grave changes, whereas it in 3

cases seemed to suggest slight dysfunction and in 1 case normal conditions.

Table 26 contains data for 10 men who had undergone mumps orchitis and for 6 controls. All had normal gonadotropin production. Pronounced bilateral atrophy of the testes was noted for 5 of the men who had undergone mumps orchitis, while the volume was normal in all the others whose testicles were measured. In one case, however, the testicular volume was on the verge of being abnormal. The spermiogenesis was studied in all cases of testicular atrophy and some of the others. Case no. O 13 is particularly interesting. He had very pronounced testicular atrophy, each testicle being about the size of a pea. Nevertheless the gonadotropin secretion was not raised. Apparently the testicular tissue (Sertoli cells) which produces the second testicular hormone showed no marked degeneration, though the germinative epithelium was totally destroyed, which was indicated by the completely extinguished spermiogenesis. However, it should be taken into account that aspermia can be due to destruction of both epididymides. The androgen production by the cock's comb test was low while the 17-ketosteroids were normal. The man was a powerful, virile type with a heavy growth of hair, strong libido and satisfactory coitus frequency. The development of penis and prostate was normal. Moreover, about one year before I saw him a pregnant woman had made him responsible for her condition which, however, reportedly ended in a miscarriage. It is doubtful how this case should be judged. A more exhaustive medical examination would probably be necessary before any statements with pretensions of accuracy could be made. It was impossible, however, to get in contact with the man some time after I had first seen him. In case O 24 also it is strange that the pronounced atrophy did not increase the FSH production still more. In this case both the cock's comb test and Zimmermann's reaction showed low values. Both the sperm samples that the person submitted were unfortunately defective and he then refused to provide any more samples. His libido was quite weak and the coitus frequency low. He complained of impotence, mainly in the form of ejaculation praecox.

Some of the cases in this table seemed to indicate that pronounced testicular atrophy can occur together with impairment of the spermiogenesis but without increased production of FSH. In such cases degeneration of the tubules has probably not advanced to Sertoli cell degeneration, provided that the latter are the site of production

Table 27. Cases with Normal or Moderately Raised Gonadotropin Excretion after Bilateral Mumps Orchitis.

Case No.	Age in years	No. of conceptions	Age at birth of last child	Urinary gonadotropin m. u. u./day	Urinary androgens I. U./day (cock's comb test)	Urinary 17-ketosteroids mg/day	Sperm assay	Size of testes ml	Prostate	Penis length cm
Single										
O 4	49	0	—	>30<60	32	9.4	not done	17	normal	11.7
» 6	47	0	—	>30<60	10	7.4	»	12	»	8.4
» 10	34	0	—	<40	not done	17.9	»	41	»	9.0
» 14	35	0	—	about 30	84	14.0	»	56	enlargement?	7.2
Married										
27	37	2	34	>30<60	16 11	9.9 8.7	slight oligoteratospermia	13	normal	7.9
30	49	3	32	>30<60	2	5.6	not done	10	[1]	6.0
33	38	1	38	>30<60	16	13.4	»	29	[1]	9.8
40	39	1	29	>30<60	56	15.3	slight oligoteratospermia	37	normal	12.0
43	44	4	38	>30<60	4	6.9	not done	11	small	9.5
55	39	3	35	>30<60	10	12.5	»	42	[1]	9.2
58	48	1	36	>30<60	58	12.5	slight oligospermia	15	small	8.3

of the second testicular hormone. Case O 24 is possibly an example of, particularly, Leydig cell degeneration. The same applies to case no. 11. In these cases the impaired spermiogenesis might be due to the lowered androgen stimulation secondary to diminished production of androgens.

In table 27 are collected 11 cases with normal or moderately raised gonadotropin production. Since spermiograms are not available for these cases, not very definite conclusions are warranted. In some of them the androgens were very low by the cock's comb test and so were the 17-ketosteroids, particularly in case 30 in which the penis was small as well.

PRODUCTION OF ACTIVE ANDROGENS DETERMINED BY THE COCK'S COMB TEST, ACCORDING TO FUSSGÄNGER

The production of urinary active androgens, as determined by the cock's comb test according to FUSSGÄNGER, should, as noted

[1] Not investigated.

previously, exceed 20 I. U. per 24 hours in normal adult men between 20 and 60 years old (HAMBURGER & coworkers, 1945). My control series comprised 25 persons in the ages between 33 and 50 years whose urinary active androgens were assayed. For 3 of these duplicate determinations were made. As noted previously the cock's comb assay method suffers from considerable errors of method, ranging from –50 to + 100 per cent. Let one of the controls illustrate this. The excreted urinary active androgens totalled 78, and in another sample about 4 months later 16 I. U. The amount of 17-ketosteroids in the same samples ranged between 8.5 and 9.5 mg. In another control the excretion was 5 and 16 I. U. of urinary active androgens and 11.4 and 11.5 mg of 17-ketosteroids. In the third of those controls who submitted more than one sample the androgen values were 16 and 6 I. U.. while the corresponding 17-ketosteroids were 6.9 and 6.0 mg. In both the latter cases about a year had elapsed between the two tests. In two of the cases the gonadotropin production was assayed and found to be normal. Under such circumstances. of course. it would be unjustified to draw anything but limited conclusions from the values obtained by the cock's comb method.

Among the 25 controls just mentioned, 10 showed active urinary androgen values below 20 I. U. (the above person with one value of 78 and another of 16 not included). Half of these 10 showed values of 10 or less. In my control group, therefore, the values were to a large extent lower than those given by HAMBURGER & coworkers.

I have also assayed the androgen excretion in 7 men born in 1922, who consequently were 27 years old when they submitted urine samples, who had undergone bilateral mumps orchitis at age 20 or thereabouts. In all these the androgen production by the cock's comb method exceeded 20, in 4 it exceeded 30 I. U.

Among 59 men who had undergone mumps orchitis 29 had an androgen production of less than 20 I. U. Those cases were not included which were tested more than once and some value was over 20 and another less than 20. In 6 of these men two assays were lower than 20 I. U.

Values of 10 I. U. or less in the only assayed samples, or in both samples, were observed in 12 of the test persons. In 2 of them such a low androgen activity was shown in duplicate determinations.

In 6 men with low values the 17-ketosteroid values were low as well according to Zimmermann's reaction (nos. O 2, O 9, O 24, 9, 30, 63).

Table 28. Excretion of Active Androgens in Normal Men, Men after Bilateral Mumps Orchitis and Castrates.

Group		No. of individuals	Mean of active androgens
Normal men (HAMBURGER)		40	44.9±3.3
My controls		25	24.5±3.4
Mumps orchitis	With moderate or no testicular atrophy	30	26.6±3.3
	With severe testicular atrophy	26	19.5±3.1
	All	56	23.3±2.3
Castrates (HART HANSEN)		16	9.9±0.9

Table 29 shows the production in those men whose gonadotropin secretion was not assayed.

I shall compare my series of mumps orchitis patients by classes, one class of severe atrophies of the testes, and one class of moderate atrophy and normal testicular volume, with HAMBURGER's normal group (40 individuals) and HART HANSEN's group of castrates (16 individuals). The determinations were carried out according to the same technique and at the same laboratory, and my normal group is fairly comparable to HAMBURGER's, so it should be warranted to draw the comparison. No attention was paid to age. The normals were from 20 to 60 years old, the mumps orchitis patients between 34 and 51 years old and the castrates between 26 and 56 years of age. In view of the large normal variations, it should not be necessary to take age into consideration.

The mean androgen production for each of these 4 groups is given in table 28. It will be seen that the mumps orchitis mean lies about 100 per cent above the castration mean and about 50 per cent below the normal mean. There is no significant difference between the two mumps orchitis groups, which is not surprising in view of the vague and uncertain division between them. However, the values for my controls are also much lower than the corresponding values for HAMBURGER's normals. It consequently seems unjustified to draw any conclusions from the results.

PRODUCTION OF 17-KETOSTEROIDS FOLLOWING MUMPS ORCHITIS

According to HAMBURGER & coworkers, and judging by the normal groups of other authors, the minimum normal production of 17-ketosteroids, at the age levels represented by the men in my

Table 29. Excretion of Active Androgens and 17-ketosteroids in Persons not subjected to Gonadotropin Assay.

Men after bilateral mumps orchitis			Controls		
Case No.	Cock's comb test I. U./day	17-ketosteroids mg/day	No.	Cock's comb test I. U./day	17-ketosteroids mg/day
Single					
O 16	24	10.6	KO 2	17	6.0
	22	10.2	» 3	6	12.4
	—	8.7	» 6	19	10.3
» 21	16	5.5	» 22	5	11.4
	32	6.7		16	11.5
» 22	20	8.6	» 27	32	6.3
	12	9.5	K 2	29	10.4
» 26	14	11.3	» 15	6	12.1
			» 17	27	10.3
Married			» 21	12	7.5
2	12	8.1	» 25	9	9.3
9	7	6.7	» 36	10	6.3
	5	3.8	» 38	20	11.5
17	10	11.5		—	12.7
	34	12.5	» 42	32	10.6
21	18	6.1	» 52	25	18.6
22	18	6.8	» 57	26	15.5
38	13	12.4			
48	25	13.2			
61	40	10.3			
70	12	8.3			

series, should be about 7–5 mg per 24 hours, whereas the mean actual secretion was about 14–10 mg. Of the 26 examined controls in my series only 3 had an excretion exceeding 14 mg per day, while in 4 the production was less than 7 mg per day. None excreted less than 6 mg per 24 hours. In view of age and sources of error, none of these cases can be considered definitely pathologic. However, the average for the group at large showed a tendency to slightly lower values than in other authors' normal groups. The mean is 10.2 ± 0.7.

The same tendency, but scarcely more pronounced, was seen for the men who had undergone bilateral mumps orchitis. Of 60 who submitted urine samples only 1 showed a 17-ketosteroid production of less than 5 mg per 24 hours (case no. 63: cock's comb test 5 I. U. per 24 hours). The production of 12 men ranged between 5 and 7 mg

per day, 47 excreted more than 7 mg per day. Of the latter only 5 had a production of 14 or more per 24 hours. The mean is 9.8 ± 0.4.

In conjunction with the account of the gonadotropin excretion, the results were also discussed of the urinary active androgen assay by the cock's comb test and 17-ketosteroid determinaton by Zimmermann's reaction for those men in whom all these hormone determinations were made. Here I shall add only a description of the cases in which only the two latter tests were carried out. This applies to 13 men who had undergone bilateral mumps orchitis and 15 controls. The values obtained in these instances are shown in table 29.

8

BODY BUILD

SOME MEASUREMENTS

As I see things it would be rather interesting if the investigation could provide data regarding the effect, if any, on physique of an attack of mumps orchitis in a mature man. I consequently took a number of anthropological measurements. All the measurements were taken according to the directions in MARTIN's "Lehrbuch der Anthropologie," and the measuring instruments were made available through the courtesy of the State Institute of Human Genetics and Race Biology, Upsala.

The measurements taken, the number of persons examined, and means for mumps orchitis patients and for controls are given in table 30. It will be seen that those who had undergone mumps orchitis had a somewhat higher stature than the controls. Consequently it is to be expected that the other measurements will also be somewhat greater. It turned out that none of the measurements differed appreciably considering the difference in stature. The body weight could tend to show, relatively speaking, slightly higher values.

Comparisons were made with some of the values obtained in a survey of 48000 Swedish conscripts (LUNDBORG & LINDERS, 1926), the set being taken which the authors found for men with a stature of 175.5 cm. The measurements, expressed in per cent of stature, are given in table 31. The comparisons have no particular relevance: the above authors measured young men and my subjects were between 35 and 50 years old. The two sets of figures are much the same.

Table 30. Means of Measurements in 75 Cases of Mumps Orchitis and 58 Control Cases.

Measurement	Mumps orchitis	Controls
Weight, kg	76.7 ± 1.2	70.7 ± 1.1
Subcutaneous fat (skin fold), mm	2.1 ± 0.1	1.7 ± 0.1
Stature, cm	175.0 ± 0.7	172.0 ± 0.7
Trunk length, cm	53.6 ± 0.4	52.8 ± 0.3
Arm length, cm	80.8 ± 0.5	80.0 ± 0.4
Leg length, cm	93.0 ± 0.6	91.7 ± 0.6
Chest-width[1], cm	97.0 ± 0.6	94.3 ± 0.7
Width on level with trochant. maj. fem., cm	96.3 ± 0.7	94.1 ± 0.7
Shoulder breadth[2], cm	36.7 ± 0.2	36.5 ± 0.3
Abdominal girth[3], cm	89.2 ± 1.0	85.8 ± 1.0
Pelvis breadth,[4] cm	29.8 ± 0.2	29.2 ± 0.2

The most used of a large number which have been designed to estimate physique and nutritional status is Rohrer's index

$$\frac{\text{Body weight} \times 100}{\text{Stature}^3}$$

In the average adult male with "normal" constitution about 18 per cent of the body is fat, while the muscular tissue amounts to about 43 per cent (cf. Vierordt, cited from Oeder, 1909). However, as the muscular tissue as well as the fat probably are quite variable amounts, this index seems to give no definite measure of obesity. If the muscles grow weak, which is possible in castration and consequently must be borne in mind in testicular atrophy and mumps orchitis, the resultant loss of muscular tissue which is the cause, or rather the result, of the weakness will influence the body weight. This effect is perhaps counteracted by the increasing weight due to increased fat formation. Accordingly Rohrer's index cannot adequately typify obesity. A better result might be had by measuring the thickness of subcutaneous fat.

A method of using the thickness of subcutaneous fat as an index for the nutritional status has been developed by Oeder (1910). It involves measurements with sliding calipers along the longitudinal axis of the body of the thickness of a raised fold of skin and sub-

[1] Middle position.

[2] Biacromial diameter.

[3] On level with the umbilicus.

[4] Inter-iliocristal breadth.

Table 31. Certain Measurements in Per cent of Stature.

Measurement	Swedish conscripts[1]	Mumps orchitis	Controls
Biacromial diameter	22.6	21.0	21.2
Inter-iliocristal breadth	16.6	17.0	17.0
Trunk length	30.3	30.6	30.7
Leg length	53.6	53.1	53.3

cuticle close to the umbilicus. In a series of 1920 persons the mean "OEDER" index for lean persons was 1.1 cm, for "normals" it was 2.75 cm. and for fat individuals 4.41 cm. I adopted OEDER's method as well and, as shown by the table, found that the difference between mumps orchitis patients and controls in the thickness of subcutaneous fat was very modest and not even statistically probable.

Rohrer's index averaged 1.43 in the mumps orchitis group and 1.39 in the control group. The higher value in the former group indicates that persons who have undergone mumps orchitis on the whole tend to be a bit fat.

The figures, thus, provide no conclusive evidence of the existence of appreciable changes in physique following mumps orchitis. The results were expected. Since no manifest changes set in after castration of adults (HART HANSEN, 1941) none can be expected following testicular atrophy due to mumps orchitis. It would be valuable to have some means of numerically defining even modes changes in physique in eunuchoidism. But we have no such means. Moreover, there are more than one type of eunuchoids, the fat and the tall lean. This holds for young castrates. Probably it is more difficult to distinguish between eunuchoidism and obesity in middle-aged and elderly men than it is to distinguish between young men who are eunuchoid and young men who are fat.

SECONDARY SEX ORGANS

Penis. The flaccid penis was measured from root to tip of glans, after retraction of the foreskin whenever it was not permanently retracted. The mean length in 57 controls was 9.0 $\pm$ 0.2 cm, $\sigma = 1.2$, range: 12.5–6.0 cm. In 73 men who had undergone mumps orchitis the mean length was 9.3 $\pm$ 0.2 cm, $\sigma = 1.7$, range: 13.3–4.5 cm.

[1] The figures refer to men with an average stature of 175.5 cm.

There evidently was no appreciable difference. (The difference between single and married persons in the mumps orchitis group was 0.7 ± 0.43 cm.)

The penile diameter was not measured, so this quantity cannot be compared with other author's results. The circumference at the root was measured in some but not all cases.

In one case only (O 2) the penis seemed to be manifestly underdimensioned: length 4.7 cm. In 3 more cases it was shorter than the minimum value for the controls (6.6 cm), viz. in cases 23 and 30, where it was 6 cm long, and in case O 22, where it was 6.2 cm long.

The following data from other investigations are given to provide a basis for comparison. In 213 men, most of them Germans aged 20–48 years, KHÊRUMIAN (1948) found that the penile length varied between 42 and 128 mm (mean: 88.6 mm), as measured with sliding calipers from root to tip of glans. He calculated whether there might be any correlation between penile length and other anthropologic data (stature, shape of head, colour of eyes and hair, blood group), but found no such correlation except a weak one between penile length and stature. FROM HANSEN (1949) found that men with a penile length of less than 50 mm and a penile diameter of less than 20 mm exhibited no or low concentration of acid phosphatase in the prostate exprimate, while it in most cases contained some acid phosphatase when the penis was 60 mm long or longer and its diameter was not less than 25 mm.

The *seminal vesicles* and *vas deferens* were examined by palpation, but neither organ seemed abnormal in the mumps orchitis group.

Prostate. Under intravital conditions the size of the prostate can only be estimated by subjective methods. It is possible to observe marked hypertrophy and atrophy by such methods, but moderate changes in volume are rather difficult to ascertain.

TÖRNBLOM (1946a) found in 208 male corpses aged 20–90 years an increase in weight with increasing years. The mean in the age-groups 30–60 years was about 20 ml.

By palpating the prostate I attempted to estimate whether its size had changed. As noticed elsewhere, the age of the examined persons ranged between 34 and 51 years. Consequently no pronounced changes should be expected in normals. The prostate was examined in 47 of 58 controls. In 37 the prostate felt "normal," in 9 it appeared to be slightly enlarged, in 1 its size seemed to be smaller than usually is the case. Among those with incipient hypertrophy of the

prostate 5 and among those with an unchanged prostate 2 complained of nycturia. The nycturia was very mild, however, one passage of urine per night and perhaps not every night. The size of the prostate was estimated in 59 of the 75 examined persons in the mumps orchitis group. In 39 the prostate appeared "normal"; in 15 the whole organ was moderately enlarged, though the finding was not conclusive in some cases. In 2 of the hypertrophic cases there was a marked preponderance of one lobe. A moderate reduction was observed in 5 cases. In no case was the reduction at all large and I am aware of the great unreliability of this observation. Negligible to moderate nycturia was present in 12 cases — 7 with moderate hypertrophy, 2 with reduction, and 3 without prostatic changes. One of the mumps orchitis test persons exhibited rather severe nycturia, 4–5 times per night. The man was 43 years old, and his prostate was unfortunately not examined. He had, however, had several diseases and had many times been hospitalized for long periods. There were no grounds for believing that the nycturia had anything to do with changes due to mumps orchitis. In all those 5 cases (nos. O 2, O 9, O 24, 43, 58), in which I thought I found reduced prostatic volume following mumps orchitis, the testicular volume was very small, i.e. they all showed severe bilateral atrophy of the testicles. The androgen production lay far below normal in 4 of these cases, in one of them the 17-ketosteroids were also subnormal while in 2 cases the latter showed borderline values and in 1 case a low but normal value. In the 5th case (no. 58) the excretion of active urinary androgens was high and the production of 17-ketosteroids normal. The control person whose prostate I regarded as hypotrophic had normal testicular volume, and despite repeated reminders he sent no urine specimen. He was single and had little or no libido (had never had coitus), but otherwise nothing abnormal was found.

Probably the examining procedure was far too subjective to give credence to the observation; but, if it is correct, the men with the smallest testicular volume and lowest androgen production (with one exception) are the ones who have a hypotrophic prostate. However, the observation fits in well with the fact that in animals castration is followed by prostatic atrophy which can be reversed by administration of testosterone or other androgens. The increased prostatic weight in test animals is used as a measure of ICSH production (Greep, Van Dyke & Chow, 1941) and choriongonadotropin secretion (Diczfalusy, Högberg & Westman, 1950). Both

Table 32. Some Anthropological Measurements in Three Cases with Suspected Eunuchoidism.

Case	Rohrer's index	Thickness of subcutaneous fat, mm	In per cent of stature				Rate B/I
			Biacroimal diameter (B)	Interilio-cristal breadth (I)	Trunk length	Leg length	
O 2	1.97	4.0	18.2	17.6	30.4	52.8	1.03
» 5	1.63	3.1	19.4	16.4	31.6	53.4	1.18
23	1.54	4.5	18.1	17.0	30.3	55.8	1.07
M. O.[1]	1.43	2.1 ± 0.1	21.0	17.0	30.6	53.1	1.23
Contr.[1]	1.39	1.7 ± 0.1	21.2	17.0	30.7	53.3	1.25
S. C.[1]	—	—	22.6	16.6	30.3	53.6	1.36

these hormones owe their effect to stimulation of testicular interstitial cells.

SUSPECTED EUNUCHOIDISM

The system of body build types which is in general use in Sweden has been made a point of criticism. It is said that we must not think of clearly delimited types when we actually are dealing with more or less arbitrarily selected cases which are called types without representing a true type conception (Dahlberg, 1948).

My group nevertheless seemed to include 3 persons who apparently deviated from the others and had a more eunuchoid or feminine bodily habitus. I shall consequently give a more detailed presentation of these men's bodily measurements and secondary sex characteristics. Data on them will be found in table 32.

Table 32 reveals that in these 3 men Rohrer's index was much higher than the means for the mumps orchitis group and the control group. Their greater obesity was also reflected in the thicker than average skin fold (subcutaneous fat). Similarly they had a markedly narrower shoulder widht in relation to stature and pelvis breadth. On the other hand they showed no departures from the average as regards the ratios between stature and pelvis breadth, trunk length and leg length, respectively.

[1] The values for these groups of mumps orchitis (M. O.), control cases and Swedish conscripts (S. C.) are means.

Fig. 11.

Fig. 12.

Fig. 13.

Case 1 (no. O 2), factory worker, 46 years old when examined in 1948, single. (Cf. fig. 11.)

CASE HISTORY: Healthy during childhood and adolescence. MUMPS at age 20, subfebrile till 4th day of illness when bilateral orchitis set in with high temperature, headache, diarrhea and vomiting. Discharged from hospital about 3 weeks after admission. Diagnosis: Epidemic mumps with bilateral orchitis (and meningeal encephalitis). Appendectomized at age 37. Since age 38 "neurasthenic" symptoms in the form of morning fatigue, evening insomnia, blushing and dizziness. Postencephalitic signs?

SEXUAL BEHAVIOUR: Coitus occurred up to age 20 and on rare occasions thereafter. Noticed marked lowering of libido following orchitis. No coitus for more than 15 years.

EXAMINATION: "Eunuchoid" type. Stature 164 cm, weight 67.5 kg. Skin fold 4 cm. Considerable accumulation of fat on abdomen, chest and thighs. Shoulder width 30 cm (mean (M) for mumps orchitis group 36.7, the value was lower than M-2 σ) which was the lowest recorded value. No pubic hair except very sparsely around the root of the penis, marginal type. Shaves at most once fortnightly. Castrate skin. GENITALIA: Bilateral testicular atrophy, total volume 11 ml. Small left hydrocele. Right epididymis atrophic (?), left normal. Penis small, length 4.5 cm. Prostate small. Fatty brests.

LABORATORY FINDINGS: Semen not studied. Urinary active androgens (two assays) 15 and 6 I. U. per 24 hours. Urinary 17-ketosteroids (two assays) 4.2 and 6.5 mg per 24 hours. FSH assay negative at 15 m.u.u. (mouse uterine units).

COMMENT: It must be presumed that this man had a normal adolescence. The

low FSH production contraindicates primary damage to the Sertoli cells in the germinative epithelium following mumps orchitis. The low urinary androgens and conditions otherwise, on the other hand, suggest Leydig cell damage. However, the great sources of error inherent in the cock's comb test must always be borne in mind, though the 17-ketosteroids were also low.

However, the signs and symptoms might also suggest a primary hypophyseal lesion. The history contains no evidence of such a disorder but, of course, it is not impossible that mumps virus can affect the pituitary gland. In the absence of a sperm analysis, a sella turcica roentgenograph, and testicular biopsy it is unjustified to make specific statements in one direction or the other. The patient could not be persuaded to submit to these procedures. It is definitely known, though, that he has undergone bilateral mumps orchitis, and therefore primary Leydig cell lesions following that condition seems the most likely alternative. But this is probably quite a rare outcome of testicular atrophy, since in most cases chiefly the germinative epithelium is damaged.

Case 2 (no. 23), watchman, 48 years old when examined in 1948, married, (fig. 12.)

CASE HISTORY: Healthy during childhood and adolescence. Operated on for right inguinal hernia at age 21. MUMPS set in 3 days later, and bilateral mumps orchitis followed 5 days after that. Peptic ulcer at age 35. Consulted psychiatrist on repeated occasions during past 10–15 years for neurasthenic troubles, particularly sexual neurasthenia.

SEXUAL BEHAVIOUR: First coitus at age 28. Married at age 34. Childless marriage (wife delivered of another man's child in 1949). No intercourse for past two years. Severe sexual neurasthenia. Postcoital oppression and anxiety which could persist for up to a month. Marital sexual maladjustment manifest in view of patient's extramarital intercourse 5–10 years earlier with a more suitable spouse with none or mild neurasthenic consequences. Absolute ejaculatory impotence not present, submitted several masturbatory sperm specimens. To some extent these masturbations were followed by distressing symptoms similar to the postcoital ones. It is doubtful whether this actually was a case of reduced libido, since the patient stated that he would like to have coitus if he did not have to fear the anxiety after it.

EXAMINATION: Eunuchoid type, stature 176 cm, weight 84.5 kg. Skin fold 4.5 cm thick. Fat accumulations particularly heavy on chest and abdomen. Shoulder width 32 cm (mean (M) for mumps orchitis group = 36.7 cm, the value was lower than M–2 σ), the second lowest-value in the group. Sparse pubic hair of marginal type. Weak bearding (shaves twice weekly). GENITALIA: Total testicular volume 24 ml. Moderate left varicocele. Slight prostatic hypertrophy (?). Penile length 6 cm. Fatty brests.

LABORATORY FINDINGS: Aspermia. Urinary active androgens (two assays) 17, and 11 I. U. per 24 hours. Urinary 17-ketosteroids (three assays) 9.0, 5.9, and 7.7 mg per 24 hours. FSH assay above 120 m.u.u. per 24 hours.

COMMENT: A man without particularly strong libido during adolescence developed bilateral mumps orchitis some days after a hernial operation at age 20. Pronounced sexual neurasthenia existed during recent years. Aspermia suggests germinative tissue degeneration. Severe Sertoli cell damage indicated by very high FSH production. Leydig cell damage might also be present.

Case 3 (no. O 5), transport worker, 44 years old when examined in 1948, single (fig. 13).

CASE HISTORY: Healthy during childhood and adolescence. Operated on for inguinal hernia. Cardiac and renal symptoms troublesome at age 40. MUMPS with bilateral orchitis at age 20.

SEXUAL BEHAVIOUR: Weak libido, no experience of coitus.

EXAMINATION: Eunuchoid type (?), stature 170 cm, weight 81 kg. Skin fold 3.1 cm. Fat accumulations particularly on chest and abdomen. Shoulder width 33 cm. Sparse body hair, sparse pubic hair of apical type. Weak or normal beard growth (shaves twice weekly). GENITALIA: Bilateral testicular atrophy, total volume 8.62 ml. Epididymides and prostate normal. Penile length normal, 7.3 cm (less than mean length in controls). Fatty brests.

LABORATORY FINDINGS: Semen not studied. Urinary active androgens 17 I. U. per 24 hours. Urinary 17-ketosteroids 8.4 mg per 24 hours. FSH assay more than 60 m.u.u. per 24 hours.

COMMENT: A middle-aged man with lifelong weak libido. The comparatively high FSH production may indicate Sertoli cell damage, but proof is impossible without sperm study and testis biopsy. Leydig cell damage is also possible.

None of these men can be called a eunuchoid with absolute certainty. This is particularly true of case 3. His laboratory findings were on the verge of normal, and his weak libido may have other reasons. He made the impression of being awake and ambitious and he had been successful at his job.

The two remaining cases, nos. 1 and 2, are more typical. Particularly case 1 with fat accumulations on chest, abdomen, hips and thighs, no body or axillary terminal hairs, lacking libido, a small penis and, perhaps, a small prostate as well, and a low production of urinary androgens and 17-ketosteroids. Contentment is the most characteristic mental trait. He minded his not very responsible and fairly simple job without being complained of and seemed to live on rather a low standard according to Swedish conditions. A certain lack of initiative seemed to colour his mental outlook. For the past few years he had been very troubled by blushing, and about 10 years ago he had consulted a doctor for a disorder of typically neurasthenic type. (The doctor in question, who kindly made his records available to me, wrote march, 1940: "Appears to be a eunuchoid, and the testes seem very small and atrophic.") In this case it does not seem improbable that the mumps orchitis followed by testicular atrophy, which the man had undergone, had brought about eunuchoid changes in the bodily habitus. The patient's history contains no other explanation than the mumps orchitis with subsequent atrophy of the testes at age 20.

Case 2 is not quite so characteristic. The signs and symptoms were fat accumulations on chest and abdomen, sparse body hair, weak but normal beard, small penis on the border of normal, low urinary androgens and fairly low urinary 17-ketosteroids. He seemed mentally contented, showed some initiative (he had for example procured a small house), and had undertaken a watchman's work which is not without responsibility but requires little physical strength. The most remarkable feature of this case was the complete sexual continence in a married man. This cannot have been the fault of the spouse, for she had given birth to another man's child. He suffered from severe sexual neurasthenia. Before his present continence he had suffered severely from postcoital anxiety. The anxiety could persist for as much as a few months after intercourse. Marital sexual maladjustment perhaps played a rôle, since he had extramarital intercourse with a spouse that suited him better some ten years ago, and then he experienced little or no postcoital anxiety. Total ejaculatory impotence was not present: he had by masturbation obtained the requested sperm samples which showed complete aspermia. And also masturbation was followed by the same kind of psychical symptoms as coitus, but they were not as intense. Whether this was a case of true impairment of libido is open to question, because he expressed a desire for intercourse if only he could escape the anxiety after it. The patient's history is not absolutely unequivocal. A week or so before he got mumps with bilateral orchitis he was operated on for inguinal hernia on the right side. The right testicle was undescended and immobilized in the upper part of the scrotum and was highly atrophic, while the left exhibited moderate loss of volume though it was soft and tender.

PART III

SEXUAL ACTIVITY AFTER MUMPS ORCHITIS AND IN THE NORMAL MALE

9

REVIEW OF THE LITERATURE

The most significant consequences of mumps orchitis are reflected in the sexual activities. Though systematic reviews apparently do not exist, this has been known for a long time as regards the ability to conceive. But very little is known concerning the effects on other sexual manifestations, *e.g.* libido and potency. Regarding the repercussions of the functional conditions of the genital glands on libido and potency data have been published, so far as I can see, only for castrated persons. ENGBERG (1948), in a paper on kryptorchism, suggested that data on the patient's libido and potency, might be used as a measure of the internal secretion of the testes. He thought, however, that too little is known concerning the sexual behaviour of normals to warrant conclusions from pathological conditions, but that information about castrates' libido and potency might be of some help. Here it should be mentioned that the information given by the patients is always more or less coloured, and therefore it is difficult to study sexuality under any conditions, be they normal or pathological.

It proved impossible to analyze the mumps orchitis patients' sex histories without recourse to data for a normal population. Attempts were initially made to meet this need by studying controls, but so few controls were available that a series of conscripts was studied also. One consequence was that the conscripts were explored at a later date, which enabled me to utilize experiences gained in interviewing the mumps orchitis patients. It was quite possible, moreover, to interrogate the conscripts more fully, and their sexual histories therefore became more complete. Those who had undergone mumps orchitis could not be troubled for too long, as they

had their jobs to attend to. Consequently results from the three groups are comparable on some points only.

Thus, the studied series comprised 79 men who had undergone mumps orchitis, 58 controls for the former, and 211 conscripts. The two first groups naturally differed from the last. The age median for the conscripts was 21.5 years, for the mumps orchitis group 41 years and for the control group 42 years.

Most works on sexual behaviour have been published in learned journals devoted to various sciences, such as anthropology, psychology, psychiatry, education, endocrinology, biology, sociology, psychoanalysis, and medicine, particularly gynaecology and urology, as well as in the form of monographs on sex life and population statistics. Also historical, social, moral and religious aspects on sex have been discussed in such works. The chief repercussion of these works on the study of the biology of sex and sexual behaviour has been that it has become increasingly evident that sex must be studied mainly from biological aspects, without applying moral and religious limitations or values.

Publications of the above type gradually prepared the ground for attacks upon the taboos, moral codes and inhibitions which have formed ramparts around everything to do with sex. Even people who were not patients became willing to part with more information, and it became possible to study entire groups of the population. The taking of sex histories was commenced in order to obtain data on the sexual behaviour of individuals or groups. For such purposes questionnaires have been the rule, in a few cases personal interviews. Sometimes a large number of questions were put, embracing as many aspects of sexual life as possible. Other investigations have had a more limited scope. Usually the most heavily tabooed forms of sexual activity, such as homosexuality and intercourse with animals, have been passed by.

Those case history studies on sex which have come to my knowledge are assembled in table 33. The table includes also data on the interviewing technique and the subjects' nationality, sex, age, and number. In addition it lists studies on women, although the subject actually is irrelevant here. American predecessors to Kinsey, Pomeroy & Martin (1948) are not included in the table, as they are listed by Kinsey et al. who, on the other hand, reviewed no European works.

Since my investigation is concerned with men, studies on women

Table 33. Review of Investigations According to the Literature.

Author	Investigation performed in	Investigation published in	Technique	Cases studied: Nationality	Occupation	Age in years	Number: Men	Number: Women	Number: Total
Lindblad	1904–06	1910	Interview	Swedish	Prostitutes	—	—	800	8
Meirowsky	—	1915	Questionnaire	German	Students	—	114	—	2
					Physicians	—	88	—	
Schbankow &Jakowenko	1908	1922	»	Russian	Women students	17—35	—	324	3
Helman	1922	1923	»	Russian	Students, men and women	16—21=37 % 22—26=43 % >26=21 %	1 214	338	1 5
Golossow-ker	1922–23	1925	»	Russian	Women students	<20=23 % 20—25=65 % >25=12 %	—	550	5
Barash	1924–25	1925	»	Russian	Workers	<23=1/6 23—50=3/4	1 450	—	1 4
Gurewitsch & Grosser	1926	1928 (1929)	»	Russian	Pupils at Workers' College	16—25= about 60 % >25= about 40 %	1 162	332	1 4
Gurewitsch & Worosch-bit	1929	1931	» (Interview)	Russian	Peasant women	15—24=>30 % 25—34=>45 % >34=<25 %	—	1 816	1 8
von Hofsten	1944	1944	Questionnaire	Swedish	Mostly workers	20—21	63	—	
Kinsey, Pomeroy & Martin	1938–47	1948	Interview	U. S.	All	All	5 300—6 300	—	6 3
Jonson, G.	1942–43	1951	»	Swedish	All	20=48 % 40=52 %	968	—	9

and the part about women in works on the sex life of both men and women will not be reviewed here.

Meirowsky (1915) published 202 statements by students and physicians regarding erotic arousal, cause of first experiences of masturbation and intercourse, domestic environment, etc. With other groups of society it probably would have been impossible to carry out such an investigation and obtain so complete and informed replies. In the form of tables and diagrams the work also gives data on age at first experience of coitus and masturbation. Most of the treatise is devoted to problems of education and sex

instruction. It should be pointed out that the type of subjects which were explored would be particularly liable to give correct replies, and that their answers were less uncritical than usually is the case. On the other hand, their answers might be coloured by their attitude to the problem later in life and would then be inexact.

The data in BARASH' (1925) work are very simply tabulated: the series was broken down into only a few age groups and the subjects were not classified by marital status. About 50 per cent of the queried persons, labourers in Moscow, filled out the questionnaires. It might be expected, therefore, that many who wished to keep their sex life secret did not reply. Probably, therefore, the treatise does not warrant any far-reaching conclusions. However, in some respects the data can be compared with my own.

WEISSENBERG's review of HELMAN's (1923) paper (original not available) does not state how many questionnaires were sent out, and therefore the percentage of replies cannot be calculated. Nor does the review contain any tabulation, which makes it difficult to judge the findings. However, the tables in GUREWITSCH & GROSSER's (1928) publication contain material from HELMAN's work for comparison with the authors' observations. It is impossible to tell whether the data are representative of Russian students—the object of HELMAN's investigation.

Among the Russian studies on sexual behaviour, GUREWITSCH & GROSSER's (1928) is the one that, comparatively speaking, is most similar to mine. The studied group comprised 1162 men and 332 women, but below I shall cite data with regard to men only. More than 50 per cent of those who filled out questionnaires were between 16 and 25 years old; two-thirds were born and brought up in a rural environment; 55 per cent were sons of peasants, 38.9 per cent of workers, and 6.1 per cent had a bourgeois background. Most of the subjects attended workers' high schools, which probably correspond more or less to Swedish vocational schools and "people's high schools" (folkhögskola). To some extent, therefore, the results ought to serve for comparison between the sexual habits of Swedish and Russian youths in their twenties with similar social backgrounds. Their results will be given in connection with my own.

So far as I can find only one study has been made of the sexual habits of Swedish youths (VON HOFSTEN, 1944). After a short lecture on the purpose of the investigation, questionnaires were distributed

to a group of 100 conscripts (with one or two exceptions fresh recruits in their early twenties). The questionnaires were collected after about 1 hour. 56 of the conscripts completed their questionnaires, 7 gave incomplete replies, 19 returned blank forms, and 18 refused to return theirs. The questions related to sex instruction, sexual experiences, contraceptives and abortions, masturbation, venereal disease, and to some general social problems.

The investigation is of limited value because of the small sample studied, which the author pointed out himself. However, its principal aim was to estimate the possibility of carrying out a more representative investigation on similar lines. VON HOFSTEN considered some of the results noteworthy: most of the subjects had acquired their sexual knowledge from books and not from friends; the first coitus took place early (median age 17.9 years) and with a temporary acquaintance; after the first experience most of them had a large number of partners (more than 10). The study contains some data of value for comparison with my findings.

GUSTAF JONSSON (1951), intending to characterize sexual behaviour in young men and the differences between their generation and the preceeding one, interviewed 968 male conscripts at age 20 and agge 40. The interviewed persons were divided into three groups: 20-year old students, 20-year old »nonstudents» and 40 year olds of the latter type. About 75 per cent of the latter two groups had a rural background. His scheme of questions covered a limited number of items. He found that about 2/5 of the students and 4/5 of the others at the same age levels had experienced heterosexual intercourse; and that the mean age of the 20-year ols at first coitus was 16.9, and of the 40-year olds 17.7 years, the difference being statistically significant. Nobody had first intercourse with his wife (i. e. after the wedding ceremony), 7 per cent of the 20 year olds and 2.8 per cent of the 40 year olds had first coitus with the fiancée. Here, too, he calculated a statistically significant difference and maintained that this differencee indicates greater erotic constancy among young men in the present generation than among the corresponding population in the preceeding generation.

KINSEY, MARTIN & POMEROY (1948) have published the first part of an investigation which is planned to include interviews with about 100 000 persons when complete and whose aim is to reflect the sexual behaviour of the entire American nation. The material yet published is based on interviews with 6,300 men and

shows the sexual behaviour of the American male. KINSEY et al. adopted the interview technique to obtain such information as they considered pertinent; they formulated a very large number of questions on social and sexual attitudes and habits; they made, and are making, every effort to assemble a really representative sample, so that they can analyze the sexual behaviour not only of the enitre population but also of small segments of society, and procure an idea not only of "normal" or common practices but also of extreme attitudes. It is naturally impossible here to present in detail the results of this broadly planned investigation. I shall return to them when I discuss my own findings. Quite a lot has been written about the Kinsey Report (DEUTSCH et al., 1948; LOTH & ERNST, 1948; BRATTGÅRD, 1950, etc.). In the below I shall discuss some significant aspects on KINSEY's method and results. KINSEY utilized the sampling and interviewing methods of modern public opinion polls (ROPER, GALLUP, MAC NEMAR, etc.) and considered that questionnaire studies provide unreliable material because of the subjects' social taboos and sense of shame. With regard to this point it should be mentioned that questionnaires possess some advantages in so far as the subject is alone and may feel more unconstrained when he is filling out the form. Moreover, all subjects will receive identically phrased questions. It should also be emphasized, on the other hand, that a personal interview can have better results, depending on the personality of the interviewer and on whether he wins the confidence of the interviewed. Obviously, however, an interview may be a failure, namely if he happens to arouse antipathy or distrust in the interviewed. In other words interviews are emotionally risky, but they may be better than questionnaires. One advantage of interviews is that they make it possible to take mental stock of the subject and to suspect when he is distorting the truth. Moreover, the possibility of turning the questions perhaps allows of better results, though that procedure entails the risk that the result will be coloured by the interviewer's wishes or expectations.

It is astonishing that KINSEY et al. secured cooperation from practically all the interviewed. The authors unfortunately did not state how many refused, which obviously is a drawback, but it seems that they were so few as to be considered unimportant. Besides, the authors seemed to think it only natural that most people would be prepared to reply without fuss and that hesitation was

exceptional. Those who were uncooperative were characterized as psychotics or contrary persons: "Occasionally a psychotic—or simply a contrary individual—has blocked at cooperating." (Saunders' Edition, p. 41; Swedish Edition, p. 67.)

KINSEY et al. pointed out that sexual contacts other than those which culminate in orgasm must also be included in the sexual activity of the mature male. "These emotional situations are, however, of such variable intensity that they are difficult to assess and compare," and consequently KINSEY let his report be "confined to those instances of sexual activity which culminate in orgasm." KINSEY pointed out further that a true picture of an individual's sexual life will not be had unless the different forms of activity in that individual are studied separately and related to one another and to the total activity. KNIGHT and BRATTGÅRD criticized KINSEY's contention that it is unnecessary to take into account the subjects' motives and attitudes, and pointed out that the psychiatrist considers these non-taxonomic aspects far too important to be left out in a complete treatise on sexual behaviour in the human male.

The characteristics of the study by KINSEY et al., and that which distinguishes it from most earlier investigations in the same field. are the size of the material. permitting subdivision into a large number of different groups (163) without having any group too small for statistical analysis, and the large number of questions, making it possible to study sexual activity from biological viewpoints.

10

CHARACTER OF THE CASES INVESTIGATED

The sex histories were obtained from 79 men who had undergone bilateral mumps orchitis, from 58 controls for the former, and from 211 conscripts.

It was possible to classify the subjects according to occupation. The result is shown in table 34.

The *mumps orchities and their controls* will first be described. Intelligence tests were not made. Nor were intelligence quotients available, since such tests had not been introduced at the time these persons did their first term of military service. It may on the

Table 34. Distribution According to Occupation of the Men in Different Groups.

Occupational groups	Mumps orchitis		Controls		211 conscripts	
	No.	Per cent	No.	Per cent	No.	Per cent
Unskilled workers	38	48.1	31	53.8	114	54.0
Semi-skilled workers	9	11.4	5	8.6	39	18.5
Artisans	24	30.4	16	24.6	43	20.4
White-collar workers	8	10.1	6	10.3	15	7.1
Total	79	100.0	58	100.0	211	100.0

whole be said that the group included no markedly feeble-minded persons, because all of them had at least completed grade school and done their first term of military service. Practically all of them had received no formal education after grade school.

All the queried persons belonged to the Swedish State Church (Lutheran). 4 orchitics and 2 controls claimed to be devout Christians; the rest were religiously inactive.

The group warranted statistical analysis of the number who had experienced coitus and the age at first experience of coitus, and for part of the sample of the relation to first partner, of the coitus frequency and of the subject's own estimation of his libido and when it was strongest.

213 young conscripts from troop units in Upper Norrland were interrogated about their sexual habits. 2 were uncooperative, and the material therefore comprised 211 sex histories. All the subjects were between 18 and 24 years old. The age distribution will be seen in table 35, which shows that 3/4 of the subjects were 21 years old. Only 13 were less than 20, or 23 years old or more. Of the 13 who were married 9 were 21 and 4 were 22 years old. One was divorced. 198 had a rural background up to age 14 and practically all of them went on living in a rural district after that age. Only 13 had always, or at least till age 14, had an urban background. All the subjects were born and schooled and had most of their lives lived in Norrland, with few exceptions in Norrbotten or Västerbotten.

166 had received grade school education only, while 29 in addition had attended a people's high school, vocational school or the like. 16 had taken the "realexamen" or "studentexamen" or had

Table 35. Distribution According to Age and Educational Level or Intelligence Quotient. (As regards the groups A—E see page 127).

Age in years	Primary school only	High school, people's high school, etc.	College, technical school, etc.	Total queried at various ages
18	1			1
19	3		1	4
20	18	4	3	25
21	123	20	7	150
22	17	4	2	23
23	3	1	3	7
24	1			1
Total	166	29	16	211

I. Q. according to test at military enrollment for 211 queried conscripts.

	A	B	C	D	E	No data
18						1
19			2	1		1
20		4	9	7	1	4
21	1	11	45	80	7	6
22		2	13	7		1
23		2	2	2	1	
24				1		
Total	1	19	71	98	9	13

gone through a technical gymnasium or acquired similar training. The distribution by educational level and age is disclosed in table 35.

The distribution by occupation is given in table 34. About 40 per cent of the subjects were employed in forestry or agriculture. The groups of unskilled, semi-skilled and skilled labourers are each about half as large as the group of forestry and agricultural workers. In addition there were a small number of trainees in forestry and agriculture, white collar workers, school teachers, engineers and students.

I did not myself test the intelligence of any of the interviewed subjects, but I had recourse to the records of the intelligence tests that every Swedish youth must undergo at enrollment. No I.Q. data were available for 13 of the subjects. These tests are made when the person is enrolled, *i.e.* in the year of the conscript's 20th birthday. In most cases they were made in 1948. Since their intro-

duction the testing techniques have been modified and improved year by year, and by 1948 certain initial weaknesses had been eliminated. The main weaknesses had been the inadequate time allowance which favoured those who rapidly could crystallize the intrinsic problem from its cloak of verbiage, *i.e.* those who were more conversant with the printed word, and the absence of examples for solution. These anomalities operated to the advantage of urban boys compared with rural boys, and probably they also gave rise to troubles for persons from the Northern Districts of Sweden where the native everyday language of a segment of the population is Finnish, although Swedish is the official language of the schools. The types of test now in force are those "which could be considered the best indicators of those intellectual faculties which make up the ability to assimilate military training." (Cited from Swedish Army Manual for Leaders of Psychological Tests in Connection with Military Enrollment.) According to their I.Q.'s the tested persons are classified into groups labelled A (highest points) to E (lowest points). The distribution of all Swedish conscripts is such that 42 per cent belong to group C, 25 per cent to each of groups B and D, while 4 per cent belong to each of groups A and E.

The distribution by intelligence level of the conscripts in my test sample will be seen in table 35. Evidently the distribution is not the same as that for the conscript population as a whole, since most of the interviewed subjects belonged in group D. However, it could be expected that the points would be lower than for the population at large, for the mean for rural conscripts is 62.1 and the total population mean 70.5, while the corresponding figures for urban boys are 88.3 and 80.3. Moreover, while the total population mean is 70.5, the mean for conscripts from Norrbotten is 61.5 and from Västerbotten 62.3. The distribution of my series by intelligence level ought consequently to be quite representative of rural conscripts from the Norrbotten and Västerbotten provinces.

All the queried subjects belonged to the Swedish State Church. Six of them said they were devout Christians, whereas the rest were religiously inactive.

No physical examination was carried out. Data on stature and weight and notes on testicular condition were obtained from the conscripts' medical cards.

Evidently the group largely was composed of 22 years old, single,

religiously rather inactive, normally intelligent, labouring, conscripts from the rural parts of Upper Norrland, with a grade school education.

Selection of the conscripts. The sampling was absolutely random and in no way influenced by me. As a rule I summoned a number of conscripts to my office. They were told to wait in the waiting room until they could enter the adjoining office. The subject was first asked about his place of birth in order to ascertain whether he had a rural background. If so the question continued with social conditions. Generally a very good rapport was established after a few minutes. Then the subject had the purposes of the investigation explained to him and the great importance of truthful replies was stressed. The interview then passed on to the subject's condition.

Although I conducted the investigation at several different military establishments, and after some days' work at one shifted over to another and then after some time back to the first, my activities naturally soon became known among the conscripts, so that they knew beforehand what the whole thing was about. However, by beckoning to persons from different parts of the waiting room, where they were sitting awaiting to be admitted to different offices, it was possible to prevent embarrassed and inhibited persons from staying away and curious and eager persons from being overrepresented. When spoken to in the presence of their comrades the conscripts were often shy and troubled, but after some minutes' conversation alone about social conditions the reaction generally disappeared and the conversation could be carried on in an absolutely natural fashion. Hesitant persons were not seldom exhorted by interviewed comrades to make themselves available. In no case did anyone refuse to begin the interview.

At other times such conscripts were interviewed as were patients at the military station hospitals. Provided they were allowed to get up, the patients were then asked to come one by one to my office to be interviewed. Most of the hospitalized patients suffered from mild and acute disorders.

When their social backgrounds had been ascertained two of the conscripts refused to continue the interview. One of them explained that in his view the whole investigation was useless and, in any case, his comrades had given incorrect answers so whatever the result of the study it would be unreliable.

The veracity of the data is an important matter. Probably it depends to a considerable extent upon the rapport between interviewer and interviewed and questioning technique. The interview always took place in a private room and there was no risk of anybody overhearing what was said. Each interviewed subject was informed of the aim of the study and the importance of truthful replies was impressed on him. He was asked not to answer rather than give mendacious replies. He was informed that the interviewer, as a scientist, offered no moral objections to any type of sexual activity and he was urged to confide in the interviewer who was in honour bound to preserve professional confidence and might be able to offer good advice. He was reassured that nobody would be able to get hold of the material, that the form was filled out in code which only an initiate can read, and that his anonymity would be preserved also in case of publication. None of the interviewed were asked for their names.

Unfortunately I was not in a position to make control interviews, nor could I check the data by other means. One of the two conscripts who refused to cooperate insisted that comrades of his who had been interviewed before him had given misleading replies. On my part I am confident that most of the subjects did their best to reply correctly, but I do not consider it impossible that some of them might have tried to hide some activity or other, *e.g.* masturbation. In such cases I dropped the subject and started discussing something else only to return later to the discomforting question from another approach. In a few cases the subject changed his reply during the interview. In doubtful cases I particularly stressed the importance of veracity and again pointed out that no reply at all would be better than a faulty reply. All the interviewed subjects assured me they had answered correctly and I can find no reason to doubt their honesty. Towards the end of the investigation I often asked those being interviewed whether previously interviewed friends had told them anything about the whole thing and, if so, whether they thought their comrades had made misleading replies. Except for the previously mentioned uncooperative conscript, none of the subject made any such assertion.

However, even if consciously wrong answers were not given to any great extent, it is obvious that the material in a study like the present one must be somewhat unreliable. In many cases the interviewed cannot remember what has happened to him. Though this

is less likely than that the subject cannot remember when something happened to him.

Data about all the subjects were secured at personal interviews. The interrogation technique and number of questions were modified somewhat in the course of the investigation, in accordance with increasing experience on the part of the interviewer, etc.

The form used during the interview to record replies was not as detailed as might be assumed from the above. It embraced 28 main headings with a few items under each. Abbreviations were used extensively in recording the replies. The sequence of the questions on the form was not adhered to, they were instead put as it appeared natural to the tenor of the conversation and seemed psychologically desirable.

With regard to heterosexual activity the material warrants conclusions concerning age at first experience of coitus and some matters about first and subsequent partners. The available data about first partner are age, virginity and her relation to the subject: wife, fiancée, "girlfriend," or temporary companions. As a rule the age of the subject is given more exactly than the age of the partner on the occasion of first coitus. The subject in exceptional cases gave his own age rather approximately, as 14–15 years. 16–17 years. In such cases the lower of the two figures was recorded; in these examples consequently 14 and 16 years. respectively. The partner's age was often given as "contemporary" or "approximately the same age" or "a year or two older." Consequently these data are less exact. With regard to subsequent partners information was secured about their numbers and virginity. and for some of the subjects. age limits and marital status.

11

HETEROSEXUAL ACTIVITY

It is scarcely possible, as pointed out before, to measure sexual activity directly. A conception may be had by recording the number of orgasms in a suitably chosen unit of time. It is socially very interesting to know the age at which individuals begin sexual intercourse that leads to orgasm. The information available in this study seems to warrant some conclusions regarding changes between the generations represented in the series.

Table 36. Distribution According to Age at First Intercourse. Frequency and Cumulative Frequency in Per Cent at Different Ages.

Age in years	No. of individuals			Annual percentage of first sexual intercourse			Calculated cumulative frequency		
	Mumps orchitis	Controls	211 conscripts	Mumps orchitis	Controls	211 conscripts	Mumps orchitis	Controls	211 conscripts
12	1	—	2	1.3	—	0.9	1.3	0.0	0.9
13	—	—	2	—	—	1.0	1.3	0.0	1.9
14	1	1	8	1.3	1.7	3.9	2.6	1.7	5.7
15	—	1	19	—	1.7	9.5	2.6	3.4	14.7
16	10	2	39	13.3	3.6	21.7	15.6	6.9	33.2
17	19	5	39	29.2	9.3	27.7	40.3	15.5	51.7
18	7	8	32	15.2	16.3	31.4	49.4	29.3	66.8
19	6	8	27	15.4	19.5	38.6	57.1	43.1	79.6
20	10	5	13	30.3	15.2	34.2	70.1	51.7	86.6
21	3	2	2	13.0	7.1	25.0	74.0	55.2	90.0
22	4	2	1	20.0	7.7	50.0	79.2	58.6	95.0
23	1	8	—	6.3	33.3	—	80.5	72.4	95.0
24	2	3	—	13.3	18.8	—	83.1	77.6	95.0
25	2	4	—	15.4	30.8	—	85.7	84.5	95.0
26	1	1	—	9.1	11.1	—	87.0	86.2	95.0
27	1	2	—	10.0	25.0	—	88.3	89.7	95.0
28	2	—	—	11.1	—	—	90.9	89.7	95.0
29	—	—	—	—	—	—	90.9	89.7	95.0
30	—	—	—	—	—	—	90.9	89.7	95.0

Of the 79 men who had undergone bilateral mumps orchitis 74, *i.e.* 94 per cent, had experienced coitus. The corresponding figures for the 58 controls is 56, *i.e.* 97 per cent. Amongst the 211 interviewed conscripts in their early twenties 184, or 87 per cent, had practiced coitus.

Table 36 reveal at what age the subjects had first had sexual intercourse leading to orgasm. It will be seen that a small number had experienced coitus at age 12. About 6 per cent of the *20-year olds* had experienced coitus before they were 15. Thereafter the frequency rose rapidly so that rather more than 1/3 of them were experienced at 16 years (before age 17). Almost 1/5 had intercourse for the first time when they were 16 or 17 years old. Respectively 17, 15 and 7 per cent experienced their first coitus at age 18, 19 and 20. Later than that very few remained unexperienced; and, moreover, so few of the subjects were older than 21 that the frequencies would be very unreliable.

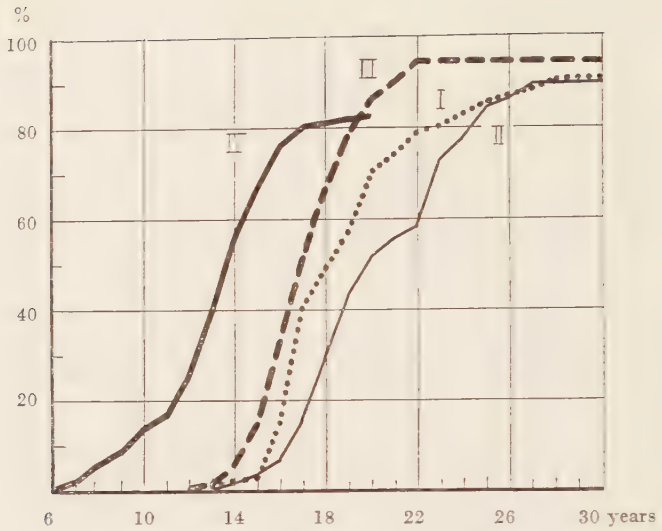


Fig. 14. Cumulative percentual frequency of first intercourse in cases of mumps orchitis (curve I), control cases (curve II), and 211 conscripts (curve III) and cumulative percentual frequency of first masturbation (curve IV), at different ages.

The *middle-aged orchitics and controls* evidently had their first experience of coitus at a somewhat higher age than the interviewed conscripts. As many as 90 per cent of the latter had sexual intercourse before they were 21, whereas only 55–75 per cent of the former had experienced coitus by that age. The samples are so small that it would be unsafe to draw any definite conclusions, but it seems probable that in general the younger generation made their experiences earlier than the older. Not until age 30 had about 90 per cent of the older men had sexual intercourse. (See also fig. 14.)

It will also be seen that there is a distinct difference between those men who had undergone bilateral mumps orchitis and their controls. The difference may of course be due to random variation, but if it is an actual one it would suggest that strongly sexed men who, one may assume, satisfy their urge early are also more susceptible to mumps orchitis.

In addition to the cases included in the table and figure the material contains two instances of coitus before age 12. A 21 year old subject stated that he at age 9–10 had intercourse a number of times in the space of a few months with a girl of similar age. He, at least, came to orgasm. Then there was an interval till he was 13–14 years old, when he had coitus with a girl of 15. Besides, he

is one of the few in the group who reported having had intercourse with prostitutes. The second case is that of a subject of 22 who had intercourse when he was 7–9 years old with a girl of similar age a few times weekly in two successive summers. He had accomplished immissio penis and thought that both had experienced orgasm. At least he had done so. On some occasions they had coitus twice in succession. They stopped, partly because they became shy of each other, partly because he acquired other interests, and partly because he learnt that coitus could result in pregnancy which he apparently had not known up to then. He was not quite sure, but thought they might have been discovered once or twice and that this had contributed to their discontinuing the intercourse. After that, he said, he had never had coitus. These two cases were not included in the table because they were interpreted as examples of advanced heterosexual play.

To provide a basis for comparison I shall here review a few earlier works (cf. table 33). Meirowsky (1915) found that 4 of 200 interviewed German students and physicians had never had coitus. None of the remaining 196 had experienced coitus before they were 14 years old. At age 16 about a third and before age 20 half had experienced coitus. The majority had sexual intercourse for the first time at age 19 or 20—about one fifth of the total at each of these age levels. Among 1162 male pupils at people's high schools who were interviewed by Gurewitsch & Grosser (1928) 1101, *i.e.* 94.8 per cent, had been involved in heterosexual intercourse. 2.5 per cent had coitus at age 11. The cumulated incidence at age 15 was about 1/5, at age 16 more than 1/3 and at age 17 rather more than 1/2. Russian students made their initial experience much later (Helman, 1923). At age 15 not quite 1/10 had experienced coitus, at age 17 just over 1/4, and thereafter the cumulative incidence increased rapidly so that 90 per cent had been involved in heterosexual intercourse at age 22. According to Kinsey et al. (1948) not quite 1 per cent of U.S. boys experience coitus at age 11. At age 14 the accumulated incidence is about 1/4, at age 15 just over 1/3, at age 16 approximately 1/2. About 80 per cent of the 20-year olds have heterosexual experience and about 90 per cent of the 25-year olds. These figures apply to the whole nation. However, it should be noted that the report shows a significant difference between urban and rural boys. Before age 15, 199 farm boys and 414 urban boys at an educational level equivalent to my subjects' showed, respectively,

the accumulated incidences of 39.2 and 51.4 per cent with experience of coitus. In the age group 16–20 years the corresponding figures for 208 rural boys and 406 city boys were, respectively, 81.3 and 87.4 per cent. In the age group 21–25 years, finally, the figures were 80.2 per cent and 90.8 per cent for 106 and 195 subjects. JONSSON, (1951) found, as noted, the same tendency as I did to a lower mean age at first coitus in the younger generation than in the older. His other figures agree well with mine.

It will be seen that my figures for Swedish country boys agree quite well with those published for Russian and U.S. farm boys. On the other hand, American city boys as a rule have coitus earlier than Russian and German students. The same applies to American college boys (KINSEY: rural 36.4, urban 42.5 per cent in age group 16–20 years).

RELATIONSHIP TO FIRST PARTNER

Information on the relationship to first partner is available for only 31 men who had undergone bilateral mumps orchitis and for 36 controls, as well as for the interviewed conscripts. The result is shown in the schedule below.

	Mumps orchitis cases	Controls	211 conscripts
Married	2	6	1
Engaged	—	—	1
Steady companion (later engaged or married)	6	8	15
Steady companion $^1/_2$ year and more	2	3	38
Steady companion, 2 m. — $^1/_2$ year	1	—	46
Steady companion, time unspec.	1	2	14
Stray acquaintance	21	17	69
No data about partners	41	20	—
Total	74	56	184

It will be seen that only a few of the interviewed had first experience of coitus with the women they married. Most of them had their first intercourse with a stray acquaintance. Everybody did not give the requisite information and the material is therefore too small to warrant definite conclusions. Only one of the conscripts evidently lived up to society's official prescript—to be married to their first partner. It may be mentioned, parenthetically, that in this case the frequency of marital intercourse was as low as once

monthly and before marriage the subject had known the girl for many years and been engaged to her. One was engaged to his first partner, and 15 were in steady companionship with theirs. 5 of these contacts led to marriage and 10 to engagement. One of the marriages had been dissolved at the time of the interview. The first partner of these 16 subjects had in 13 instances been a virgin. In regard of the next three groups of more or less lasting companionship the material is naturally more unreliable and the transition to more temporary contacts not very clear. Of the more lasting contacts, 38, only 8 were in force at the time of the interview, while among the 46 less durable ones only 1 was in force. The first coitus was had by 69 of the subjects—*i.e.* 37.5 per cent of the 184 with heterosexual experience and 32.7 of all the 211 interviewed—with definitely temporary acquaintances only 3 of whom were virgins.

To provide a basis for comparison I shall here cite corresponding findings from other published investigations. According to Meirowsky 2/3 of German students had first intercourse with prostitutes and 1/3 with stray acquaintances. In Gurewitsch & Grosser's series 4.4 per cent had first coitus with wives, 25.8 per cent with steady companions, 3.8 per cent with relatives, 3.7 per cent with some kind of domestic servants, 53.3 per cent with stray acquaintances and 9 per cent with prostitutes. About 10 per cent of von Hofsten's subjects experienced first intercourse with their fiancées, about as many with steady companions, about 75 per cent with stray acquaintances and 2 of 49 queried with prostitutes. The same tendency is apparent in various publications. The differences may in part be due to differing conceptions regarding steady companionship and stray acquaintances. So far as I can see Kinsey et al. have not taken up this socially important question in their exhaustive work.

Among the 184 sexually experienced conscripts 40 had been involved with only one partner. For all but one of the remaining 144 data are available regarding the number of partners. The figures are very approximate, however, since very few of the interviewed strangely enough could state exactly the number when they had been involved with many or a few partners. In such cases the given figure usually was approximate, *e.g.* about 10, about 20, 10–15, etc. When two figures were given the lower was always recorded. The aforementioned 143 subjects had been involved with 1452 partners after the first.

It would be interesting to know the incidence per cent within age classes for involvement with one partner only. It is to be expected, naturally, that those who started having heterosexual intercourse earliest have been involved with the most partners, particularly if the early start was due to strong sexuality. It is to be expected, likewise, that very early contacts are not very firm. Owing to the short observation time, however, the data provide no definite indications in this respect. In part the material is inadequate to warrant conclusions from the percentages and means. All that can be safely assumed is that a comparatively large number of those who started having sexual intercourse as 16 or 17 year olds—about 95 per cent at each of these age levels—when interviewed 1–8 years later had been involved with more than one partner. The number of subsequent partners is naturally highest for those who began having coitus comparatively early, *i.e.* as 14 to 16 year olds, for which group the average number of partners is 10–20. Thereafter the number of partners goes down because the observation time from first coitus to the interview decreases.

We have seen that no data regarding the age and number of subsequent partners are available for 1 of the 144 with more than one partner, whereas the approximate number but not the age can be determined for 30 subjects. Of the remaining subjects 12 had had only 1 subsequent partner, and 101 subjects could give the age of the oldest and of the youngest partner. Only a few of the subsequent partners were over 25, one was under 15, and it turns out that the subjects on the whole kept to partners of a similar age. Only 40 of the 184 subjects who had sexual experience had been involved with a single partner.

Table 37 shows the first partners' age and virginity. Evidently 20 of 184 girls were 15 or younger, 2 were 12 and 5 were 14 years old. Most of the interviewed subjects experienced first coitus with 17-year olds, but a large number did so also with girls 18, 19 and 16 years old. Compared to the boys' age at first experience the girls were consistently somewhat younger. The only noteworthy difference seems to be between age 16, at which most of the boys have their first experience, and age 17 when, judging by the boys' statements, many more girls seem to have their first experience. It should be noted, however, that the age of the girl usually was given much less definitely than the subject's own age, often as "same age" or the like.

Table 37. Age of First Partners and Incidence of their Virginity at Different Ages.

Age in years	Men		First partner		of whom virgins	
	No. with first intercourse	In per cent of total	Number	In per cent of total	Number	In per cent
12	2	1.1	2	1.1	2	100
13	2	1.1	—	—	—	—
14	8	4.3	5	2.7	4	80
15	19	10.3	13	7.1	4	31
16	39	21.2	23	12.4	5	22
17	39	21.2	55	29.8	18	33
18	32	17.4	39	21.2	8	21
19	27	14.7	26	14.1	7	27
20	13	7.1	10	5.4	3	30
21	2	1.1	6	3.3	—	—
22	1	0.5	1	1.1	—	—
23	—	—	4	2.1	1	25
Total	184	100.0	184	100.0	52	28.3

Of the 184 girls 52 were virgins. The relatively largest number of virgins is to be found among the 17-year olds, viz. 1/3, but the difference between various age levels is not large, and the material does not warrant definite conclusions.

The data supplied by the young men permit evaluations of the frequency of coitus as the first sexual experience. This was the case in 34 instances. 10 of the latter subjects denied experience of any other sexual activity. Of the remaining 24 subjects 10 had experienced also masturbation and nocturnal emissions during sleep. The latter form of activity had come up to a couple of years after first coitus for 4 subjects, one had begun to masturbate and experience nocturnal emissions at the same time as coitus, and 5 had begun to masturbate at the same time but had nocturnal emissions later. The other 14 had experience of only one form of sexual activity besides coitus—in 4 cases masturbation and in 10 nocturnal emissions.

LIBIDO

It is interesting to know the age of maximum libido, even if such a statement naturally must be rather subjective. The libido is a function of a series of different factors, viz. physical, particularly

Table 38. Per Cent of Cases with Weak Libido.

Group	No.	Per cent with weak libido		
		Before age 20 or before mumps orchitis	Between age 20—30	The last 2—3 years
Mumps orchitis cases.....	79	12.7 ± 3.8	7.6 ± 3.0	19.0 ± 4.4
Control cases.....	58	12.1 ± 4.3	10.3 ± 4.0	12.1 ± 4.3

endocrine conditions, mentality, environmental background, and not least the possibility of satisfying it. On the one hand, the libido may be considered strongest when the environment stimulates the individual's sexuality markedly and there are no outlets for the urge; on the other hand, it may be regarded as strongest when it is directed towards a particular person and there are numerous opportunities to satisfy the craving, *e.g.* in wedlock, particularly its first phases. Then the coitus frequency is often highest, but a maximal coitus frequency is not a reliable indication of maximal libido.

The libido was studied only for the mumps orchitis patients and their controls. It was evaluated partly from the person's own statements and partly from the coitus frequency. In this manner I attempted to estimate whether a history of bilateral mumps orchitis had affected the libido. The result is given in table 38. It will be seen that there is no marked difference between those who had undergone mumps orchitis and the controls. There admittedly was some difference at the time of the interview, *i.e.* 10–30 years after the disease, when it was 6.9 ± 6.1 per cent. Consequently it would not be warranted to draw conclusions whether a history of mumps orchitis has any after-effects in the form of depressed libido.

The coitus frequency at the time of the interview appears in table 39. The difference is not significant, but the figures suggest that low frequencies, less than once monthly, are a bit more common in men who have undergone bilateral mumps orchitis than in controls.

In order to reduce the influence of environmental factors, which particularly ought to affect the coitus frequency of single men, I have in the table given figures for married men separately. The latter figures also reflect the same tendency with regard to the coitus frequency. A low coitus frequency obtains in 12.7 per cent of the former and 3.9 per cent of the latter. The difference is 8.8 ± 5.2 per cent.

Table 39. Frequency of Intercourse at the Time of Examination.

Group	No.	Per cent and standard error		
		Seldom or never	1—4 times monthly	> 4 times monthly
Total mumps orchitis cases	79	22.8 ± 4.7	55.7 ± 5.6	21.5 ± 4.6
Total control cases	58	10.3 ± 4.0	65.6 ± 6.2	24.1 ± 5.6
Married mumps orchitis cases	55	12.7 ± 4.5	60.0 ± 6.6	27.3 ± 6.0
Married control cases	51	3.9 ± 2.7	70.6 ± 6.4	25.5 ± 6.1

POTENCY

These data are also somewhat unreliable, because the subjects' statements cannot be checked. (Sometimes, however, the spouse could be interrogated.) For 6 of those who had undergone bilateral mumps orchitis it was impossible to secure information regarding potency: they had never (5) or not for many years experienced coitus. The same applied to one of the controls. The potency had always been good in 51 of the controls. So was the case in 56 of those who had undergone mumps orchitis.

Of the 58 controls 6, or 10 per cent, reported mild potency disturbances. Among the 78 men who had undergone bilateral mumps orchitis 16, *i.e.* 20 per cent, complained of reduced potency; in four of them it was a matter of severe impotence with sexual neurasthenia. In 12 of them the disturbance was mild, and due to sexual maladjustment to the partner or to ejaculatio praecox with low coitus frequency. In 4 cases the distress took the form of severe impotence, in 1 combined with exceedingly severe sexual neurasthenia. However, in two of them it was uncertain whether mumps orchitis was the only or even the major cause of the impotence. One of these men, a 48 years old sailor, associated his symptoms with a mild psychotic disorder he had acquired while he was on hazardous marine duty during the war. The other, a 49 years old mill hand, attributed his impotence to diabetes for which he was treated at hospital when he was 43–44 years old.

It seems quite likely that impotence and mumps orchitis stood in a causal relationship to one another in the remaining two cases. One of the men, a 38 years old shopworker, had noticed reduced libido after mumps orchitis. After the disease his erections were

rather weak and he suffered from ejaculatio praecox as well. Owing to setbacks in attempting to perform sexual intercourse he had more and more refrained from coitus. He unquestionably suffered from his condition. He showed low androgen secretion, on the verge of normal, decreasing fertility, and oligo-astheno-teratospermia. The other man, a 48 years old watchman, suffered from pronounced sexual neurasthenia with postcoital anguish. He showed a eunuchoid constitution, low androgen secretion and extremely high secretion of gonadotropic hormone, and aspermia.

I have also investigated whether there is any correlation between testicular volume and, respectively, libido and coitus frequency. Those who had undergone mumps orchitis were classified into groups with bilateral and unilateral atrophy and a group with normal testicular volume. It turned out, however, that reduced libido was just as common in those with normal testicular volume as in those with bilateral atrophy of the testes. The same lack of correlation obtained between testicular volume and coitus frequency at the time of the interview: 20 ± 7 per cent of the men with bilateral atrophy of the testes reported a coitus frequency of less than once monthly: the corresponding figure for men with a normal testicular volume was 28 ± 8 per cent.

APPENDIX

When I interrogated the conscripts about their sexual behaviour I also took up some questions, which were of secondary importance to the mumps orchitis study. Nevertheless the results of this investigation seem to be of some interest. Consequently a brief survey of my findings is given as an appendix.

ACQUISITION OF SEXUAL KNOWLEDGE

The interviewed subjects were requested to state at what age they acquired knowledge concerning coitus, conception and contraceptives, and where they had got the information from. Generally speaking these subjects did not receive sex instruction at school. Many stated that sex instruction was supposed to be introduced at the school the year after they left. I cannot help feeling that the data on age must be fairly unreliable. When the answer was quick and certain the queried had not seldom misunderstood the question. It is naturally very seldom that a person acquires complete knowledge about these things all at once—the pieces fit in gradually. If the acquisition of sexual knowledge is not associated with some very special event or events, which are etched into the memory, the reply will be rather vague. As an example of such associations I can mention the case of one subject who acquired his sexual knowledge in conjunction with police investigations that were carried out after the discovery that an elderly man who gave board and lodging to school children had forced a boy and a girl, both minors, to cohabit. Another subject had a very vivid memory of having been informed by an adult man on a short journey. However, such clear mental pictures are rare. The lacking reliability of the data are also evident from the fact that some of the subjects, who had been involved in very advanced heterosexual play during childhood, stated that they had not realized the significance and implications of coitus till much later, namely, when friends had told them about sex.

The subjects were also asked from whom they received their information and how old they were when they first really understood

the implications of their observations and replies given to their questions. We know that small children think that animals having intercourse actually are playing, until they can associate such observations with knowledge gathered in other ways. Strictly speaking, of course, it is impossible to fix an exact time for acquisition of knowledge regarding such social activities as these, which are not taught systematically early enough not to be preceded by accidentally acquired and more or less precise observations of a general nature. I endeavoured to fix the time when the subject actually understood an observed sexual act, *e.g.* animal intercourse, or something spoken about by friends or parents, *e.g.* coitus. Despite the above reservations data on age are given here because they might provide some guidance in judging the acquisition of sexual knowledge. Of course, the age data for those subjects who acquired sexual knowledge through sex instruction at school are almost exact. It was rather interesting to note that often those who declared they had acquired sex knowledge through books did not refer to technical books but to books in the field of letters. However, the latter books were often of the type intended to spread knowledge. Such literature was not included here as my evaluation referred only to real manuals on sex.

As could be expected, most of the subjects were informed by friends. Only two denied having talked with friends about sex. Not quite 20 per cent (41 boys) were informed by their parents, but mostly in the form of warnings against the consequences of intercourse, such as pregnancy and venereal disease. Often these boys were told about sex when they were 13–16 years old. Instruction at school was received by 64 boys (30 %), most of whom considered it rather futile: it had come too late (for most of them at age 13) and was much too superficial.

Table 40 reveals, that most of the subjects, about 65 per cent, acquired *first knowledge* of coitus by seeing animals copulate. About 1/3 were informed by friends. Knowledge acquired at a very tender age is usually a product of visual observations and informations from friends, and it is probably impossible in practise to discriminate one source from another. The pertinent fact is that only very few (7 of 209) of the subjects were instructed by their parents. All the 64 boys who had attended sex-classes at school already knew about coitus.

Table 41 and fig. 15 (cumulative frequency) give data concerning

Table 40. Distribution According to First Source of Knowledge Concerning Intercourse.

Age in years	Number of queried = N	First knowledge came from					
		Observations of animals		Friends		Parents	
		No.	Per cent of N	No.	Per cent of N	No.	Per cent of N
5— 7	27	22	81.5	5	18.5	—	—
7— 8	43	32	74.4	7	16.3	4	9.3
8—10	51	32	62.7	17	33.3	2	3.9
10—14	78	47	60.3	30	38.5	1	1.3
14—17	10	2	20.0	8	80.0	—	—
Total	209[1]	135	64.6	67	32.1	7	3.3

Table 41. Distribution of Age of First Knowledge Concerning Intercourse, Conception and Contraceptives. Percentual Cumulative Frequency.

Age in years	Intercourse		Conception		Contraceptives	
	Number	Cumulative frequency in per cent	Number	Cumulative frequency in per cent	Number	Cumulative frequency in per cent
5	1	0.5	—	—	—	—
6	6	3.3	2	0.9	—	—
7	13	9.5	11	6.2	1	0.5
8	17	17.5	11	11.4	2	1.4
9	20	27.0	21	21.3	8	5.2
10	31	41.7	30	35.5	16	12.8
11	21	51.7	17	43.6	16	20.4
12	38	69.7	44	64.5	28	33.6
13	25	81.5	29	78.2	34	49.8
14	15	88.6	19	87.2	38	67.8
15	15	95.7	15	94.3	36	84.8
16	4	97.6	6	97.2	21	94.8
17	3	99.1	2	98.1	5	97.2
18	2	100.0	1	98.6	4	99.1
19	—	100.0	1	99.1	1	99.5
20	—	100.0	—	99.1	1	100.0
Total	211	—	209	—	211	—

[1] Two cases with incomplete data are excluded.

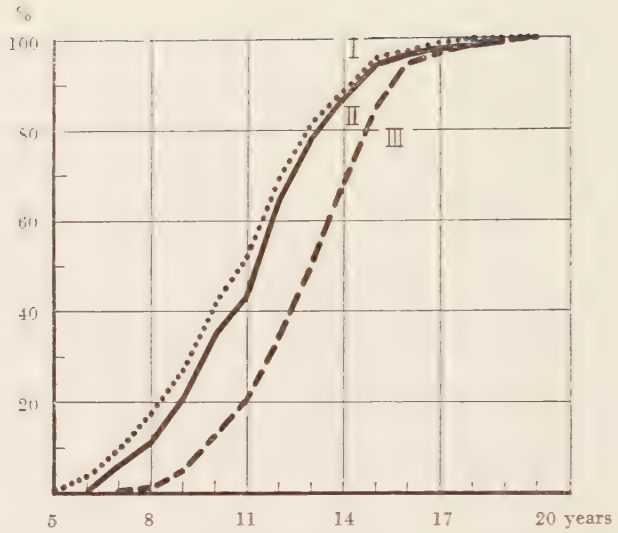


Fig. 15. Cumulative percentual frequency of men at different ages who had then acquired knowledge of sexual intercourse (curve I), conception (curve II), and contraceptives (curve III).

the age level when knowledge was acquired about coitus, conception and contraceptives. As could be expected, information regarding coitus and conception is acquired at about the same time, for coitus negligibly earlier, whereas insight into contraceptive methods as a rule comes somewhat later. It will be found, by comparing the accumulative incidence curves for coitus and information about contraceptives (figs. 14 and 15), that the overwhelming majority knew about contraceptives before they first attempted coitus. However, one subject had first intercourse without contraceptives with a girl of 17. He then had not the faintest idea about contraceptives and was informed very soon thereafter by an elder brother.

It may be mentioned by way of comparison that 17 of VON HOFSTEN's subjects had attended sex instruction classes at school while 46 had not. 12 thought the instruction beneficial, 7 did not. Parents were the source of knowledge in 16 cases, friends in 31, confirmation coaching in 3 and books in 53 cases. VON HOFSTEN was surprised that so many had obtained information on sexual problems from books. It will be remembered that also a large number of my subjects had informed themselves from books, though prior information generally had come from other sources, mainly friends, and many had already experienced coitus. Considering the

great importance the church assigns to chastity, it is remarkable how few confirmation coaches gave sex instruction, in VON HOFSTEN's series only three. Of the 211 conscripts interviewed by me 133 had been confirmed (data lacking for 19). Of these 133 only 20 stated they had received sex instruction from the confirmation coach.

"The Kinsey Report" gives no data on the age when sexual knowledge is acquired, nor on the sources of knowledge. Neither did MEIROWSKY or HELMAN. GUREWITSCH & GROSSER found that 12.2 per cent acquired knowledge concerning sex life ("geschlechtliche Aufklärung") before age 10, 8.6 per cent at age 10, 17.5 per cent at age 11–12, 20.6 per cent at age 13–14, 22.6 per cent at age 15–16, 12.5 per cent at age 17–18, 4.4 per cent at age 19–20, and 1.6 per cent when they were more than 20 years old. Evidently these ages are considerably higher than in my series. The authors gave as the source of information friends in 79.7 per cent, parents and teachers in 6 per cent and other persons in 8.6 per cent. Direct observation of coitus occurred in 14.9 per cent, of animal intercourse in 23.6 per cent, while 23.1 per cent informed themselves from books.

PETTING

My schedule of questions was constructed to provide data on the occurrence of intimate physical contact involving deliberate attempts to effect erotic arousal and ultimately orgasm but not genital union. Among the previously mentioned 213 conscripts 188 were queried on this subject. Such experience was denied by 128 individuals, or 68 per cent. Of the rest, 35 had never petted to orgasm and, besides, most of them had been involved in such activity a few times only. At some time 23, *i.e.* about 12 per cent, had achieved orgasm in conjunction with petting. Only a few experiences of heterosexual petting were reported by 14 of these, *i.e.* about 7 per cent of the 188 interviewed subjects. The last 9 (5 %) had systematically indulged in petting over prolonged periods with orgasm once or twice to a few times weekly. In all these cases the partner at least sometimes came to climax. Some of the subjects who had not themselves achieved orgasm stated that the partner had done so. For some subjects there are data regarding petting but no specified information.

The ultimate object of the activity in many of these cases was

apparently coitus rather than petting, but for fear of pregnancy the woman had balked. In many cases this was the reason given. Among those who did not directly deny having engaged in petting 7 stated that the partner had been the present wife or fiancée who at first had not dared to consent to coitus.

Apparently KINSEY et al. are the only researchers who have published petting incidences. Among 259 rural boys at the same educational level as the subjects in my group in the age class 16–20 years they found petting in 17.8 per cent. In the age class 21–25 years the corresponding figure was 141 or 12.8 per cent. Thus, KINSEY's figures and mine are of the same order.

CONTACTS WITH PROSTITUTES

Only 4 of the young men admitted coitus with prostitutes. For only one of them the contact had taken place in the rural districts of Upper Norrland. He was then 20 years old and had paid 5 kronor. When he was 18 one of the subjects had been a sailor and had then contacted a prostitute on 5 occasions abroad but never in Sweden. The payment had been a box of cigarettes or small sums of money. When he was 19–20 another had 3 times had intercourse with prostitutes and had paid 20 kronor each time. The last, at age 20, had 4 times had coitus with prostitutes in Stockholm. The payment had been 20 or 40 kronor; except once when it was 70 kronor, then he had shared both the fee and the prostitute with a companion.

Evidently the reason for the low frequency of intercourse with prostitutes is that prostitutes are few and far between in Norrland; at least they are rarer than in large cities.

MASTURBATION

Among the 211 interviewed subjects 175 had masturbated during some period of their lives, which is equivalent to 82.9 per cent. Table 42 shows the age at first experience of masturbation for the 174 experienced of 210 subjects. One of the subjects was not included because he was too vague about the time when he began to masturbate. He could only say he did it during school age. It will be seen that some of the subjects could remember that

Table 42. Distribution According to Age at the Beginning of Masturbation. Frequency and Cumulative Frequency at Different Ages in Per Cent.

Age in years	No. of individuals	Annual Frequency of first masturbation in per cent	Cumulative frequency in per cent
6	1	0.5	0.5
7	4	1.9	2.4
8	8	3.9	6.2
9	6	3.0	9.0
10	11	5.8	14.3
11	7	3.9	17.6
12	17	9.8	25.7
13	30	19.2	40.0
14	34	27.0	56.2
15	24	26.1	67.6
16	19	27.9	76.6
17	8	16.3	80.4
18	2	4.9	81.4
19	2	5.3	82.4
20	1	3.1	82.9
Total	174[1]	—	—

they began to masturbate when they were 6 or 7 years old. Then the incidence per cent increased slowly for the next 5–6 years, the accumulative incidence at age 12 being 25 per cent with experience. The next 4 years the experienced increased by 10–15 per cent annually. At age 16 more than 75 per cent of the subjects had experience of masturbation. The increase after that is insignificant. The incidence of experience at different age levels is shown in fig. 14, p. 132.

The material allows calculations of how many still masturbated at the time of the interview and the age when the others stopped. Among those with experience of masturbation 18.6 per cent were still active at age 21. The others generally stopped when they were 15–19 years old, about as many at each of these age levels.

The curves showing the incidences of coitus and masturbation (fig. 14) reveal that about 25 per cent had experienced masturbation by the time of their first coitus. From that age level the incidence of masturbation increases sharply but the incidence of coitus

[1] 1 additional case; age not given.

very moderately. From the age level, 15 years, when the increase of masturbatory experience begins to level off, the experience of coitus begins to increase at a high rate. It should be noted that about 5 per cent more of the total series had experience of coitus than of masturbation.

It is naturally interesting to compare my figures with other authors'. Rohleder (1913) surveyed his predecessors' results with regard to the incidence of masturbation, finding that different authors have figures ranging between 60 and 100 per cent. His own findings were that an average of 90 per cent of all young men masturbate during the second decade of their lives and they generally do so for some years.

Meirowsky (1915) queried students and physicians and found that 71 per cent of the former and 88.7 per cent of the latter had masturbatory experience. He compared his results with others': Marcuse, 92 per cent; Cohn, 99 per cent: Helman, 52.8 per cent; Petrenko, 63.6 per cent; Tschlenow, 73.4 per cent. The last three authors observed Russian subjects and were reviewed by Gurewitsch & Grosser (1929) whose own figure was 55.1 per cent. von Hofsten did not state the incidence per cent of masturbatory experience in his series. Kinsey et al., lastly, found that 92 per cent of all U.S. males had experience of masturbation, whereas his figure for the rural population corresponding to my series in education and age was 85–90 per cent. Lower incidences are reported in some earlier reports from the United States. It should be noted that the published incidences vary considerably. There is a tendency to higher figures the higher the educational level of the interviewed subject.

With regard to the age when masturbation begins, Meirowsky started his statistics with 5-year olds and stated that 4 per cent began to masturbate when they were 5–8 years old. Kinsey et al. started their statistics with 8-year olds, at which time 0.1 per cent received their first experience. They stated that relatively few preadolescents actually masturbate, viz. about 10 per cent before age 9 and 13 per cent before age 10. They found, further, that 45 per cent are active at age 13, 90 per cent at age 17, and about 93 per cent at age 21–22.

I also tried to estimate the young men's attitude from moral aspects and their beliefs concerning the consequences of masturbation. Certain that it is harmful to masturbate were 34, while 45

were not convinced but supposed it is unhealthy. 47 were sure of its harmlessness, while 25 were inclined to think the same without being positive. No opinion was held by 42 subjects. Most of them were unable to give reasons for their view; 7 had read and 5 heard that masturbation is harmful. A few had heard or read the opposite. A small number claimed they had been unfavourably influenced in the form of anguish, lacking satisfaction or the like, and some said they felt ashamed after masturbation.

71 had no moral scruples, 10 were not quite sure but believed it was not immoral, 63 were convinced masturbation is immoral, 36 were not as sure but assumed it should be considered immoral, and 21 were completely undecided.

In the main, therefore, it may be said that as many were positive and negative with regard to the harmfulness and immorality of masturbation, while a smaller number held no opinion for or against the problem. Not all thought the practice both immoral and harmful. Many who considered masturbation immoral thought it was harmless, and many who thought it harmful had no moral objections.

HOMOSEXUALITY

Since homosexual activity probably is the most taboo form of sexual activity, I took particular pains to elicit information not only on any homosexual activity that the interviewed subject might have taken the initiative to, but also on whether he had been asked to partake in such activity and on his attitude to homosexuality.

Amongst the 211 subjects 177, *i.e.* 83.9 per cent, denied having been involved in any form of homosexual behaviour whatsoever. Such activity had not even been suggested to them and the very thought was repulsive to them. However, they had heard tell about homosexuality.

Of the remaining 34 subjects 30 had been victims of more or less direct approaches and suggestions from homosexual persons. For 23 this had taken place only once or twice. For 10 subjects these events had happened in cities, 6 of the cases in large cities in Southern Sweden. In a very few instances the approaches had been made outside urban communities. Liquor had been quite an important

persuasive element. in some cases payment had been offered. All the subjects had refused to participate. sometimes very brusquely.

Only 4 of the subjects admitted they had not taken a completely negative attitude. None of them admitted having taken the initiative to homosexual acts. They had in some cases had erection but in no case ejaculation.

The data in the literature concerning the incidence of homosexuality range between 0.1 and 100 per cent. The latter figure refers not to experience of homosexuality, it is given by psychiatrists who claim that all males have homosexual tendencies. Such an interpretation of the concept can be neglected here. The incidence ranges between 2 and 5 per cent in most investigations, *e.g.* HIRSCHFELD's and ELLIS' works. Much higher figures have been found in recent American studies: HAMILTON (1929), 17 per cent; RAMSEY (1943). 30 per cent: FINGER (1947). 27 per cent (cited from KINSEY et al., 1948).

However. with regard to this problem KINSEY's report has caused the greatest astonishment. The authors interviewed persons who have had physical contacts with other men and come to climax because of such contacts. They pointed out that, of course, homosexual activity may occur without orgasm but used the above definition in calculating incidences and frequencies. The incidence of homosexuality was about 40 per cent of the 20 years old male population, among grade school youths it was 30 per cent, and among rural single men at the same educational level as my subjects it was 21.2 per cent in the 16–20 year group and 17 per cent in the 21–25 year group. Since KINSEY's figures are so very much higher than any published before. except for the previously mentioned ones by U.S. psychiatrists, it was necessary to test the accuracy of the figures. KINSEY et al. pointed out that the finding of such high incidences of homosexuality made them astonished and doubtful. They consequently took particular pains to test their results by comparing the responses given in two different interviews with the same person by the same interviewer and found 90.4 per cent identical replies (coefficient of correlation: 0.95).

By cross-checking and repeat questions during the interviews they attempted to ascertain whether the subjects remembered rightly and gave correct answers. The results were also proved in the following manner: by comparing perfectly randomized samples of various sizes from the aggregate. by comparing 100-per-cent samples

and partial samples, by following trends in consecutive age groups, by comparing samples for males with varying onset of adolescence, by comparing educational levels and occupations, by comparing two generations with an age difference of 22 years, by comparing urban and rural groups and differing religious adherence.

As pointed out in the review of literature, KINSEY et al. seemed to think that the actual incidence lies somewhere between the incidences for partial and 100-per-cent samples. For homosexuality in the 16–20 years age group the incidence difference between partial and 100-per-cent samples was 4.8 per cent (17.1–12.3), and in the 21–25 years group 4.7 per cent (10.4–5.7). These figures are evidently lower than those I have given above as KINSEY's findings for single farm youths between 16 and 25 years old at the lowest educational level. The difference may have come about through the fact that the latter figures refer to the total population of both single and married men. In this connection it should be noted that the figures for homosexuality in the Kinsey Report are between two and three times higher for single than for married men at these age levels. This may have had some effect although 4 out of every 5 persons were single. Another point is that the college population —4 5 of the interviewed subjects—is overrepresented, and at this educational level the incidence of homosexuality is lowest.

Let it be assumed that KINSEY et al. are right. Then the actual incidence of homosexuality among U.S., single, farm boys with a grade school background would lie between 15 and 20 per cent in the 16–20 years group and between 10 and 15 per cent in the 21–25 years group. The mere fact that the incidence is lower in the higher age group, which incidences actually cannot be, shows how unreliable the calculations are. Also, among the forms of sexual activity that ought to be higher if a total population survey were made and everybody told the truth, homosexuality is the most important one because of the public opinion taboo that would make people inclined to be a bit careless of the truth.

Even if the figures are unreliable, however, it is obvious that the figures in the Kinsey Report and in my study are completely at variance with each other. With respect to sample size the series are well comparable. KINSEY's sample of farm boys at the lowest educational level consisted of 259 subjects in the 16–20 years group and 141 in the 21–25 years group. My series, as described in detail elsewhere, comprised 211 young men between 18 and 24 years old.

Of these 198 had a rural background. 195 of whom had a grade school education and 29 of the latter had attended people's high schools etc. on top of that. Consequently the samples are well comparable with regard to age. background and educational level.

It is important to know, naturally, whether my results are correct. As I have emphasized elsewhere I was unable to re-interview any subjects or undertake other checking procedures. The following comments may be made. My results would seem to indicate that there is zero homosexuality in the rural districts of Upper Norrland. This is obviously fallacious. and the interviews with some of the subjects told another story. Besides. it is probable that one of the subjects had partaken in homosexual activities. He told a detailed story of how friends during the last school year. *i.e.* at age 12–14. had homosexual intercourse leading to orgasm with one another. At least occasionally the frequency was once daily. I consider it probable that the subject had been involved himself. He stated that all his friends had stopped the practice when they began to go out with girls. His own first coitus took place when he was 17 and at the time of the interview he had a steady girl friend. (He was one of the few who had been having intercourse with prostitutes.) When he was 9 another subject had been made the object of homosexual activity by a 20 years old relative who came to climax. Besides. many of the subjects knew of homosexual individuals in their home districts. Practically all of them. however, were stated to be older than the subjects.

If it is assumed that my data are truthful. the only thing that can be stated with any certainty is that homosexuals up to age 23–24 are very few and much rarer in the rural districts of Norrland than in the rural districts of the United States. particularly the West, if KINSEY et al. are to be believed. The latter authors expressed the opinion that young men only have each other on isolated farms and in such places as forest camps. and that the mores do not sanction intercourse between boys and girls in their teens. The situation is obviously quite different in Swedish rural districts where young persons meet at a fairly low age on saturday and holiday evenings. However, quite a large proportion of my group were agricultural and forest workers. many of whom were isolated in forest camps for months on end. In the beginning of the investigation I suspected that some homosexual activity would be quite likely under such circumstances. I consequently went to great

lengths to elicit information on homosexual activity at such times, but could secure not a scrap of evidence. Further, most of the replies reflected a very strong aversion against homosexual practices. Though an attitude conforming with the mores must not be given overdue weight in judging what actually might have happened, I received a distinct impression that homosexuality is very rare in the rural parts of Upper Norrland.

SUMMARY

The review of literature reveals that the incidence of mumps has been treated statistically by a number of authors. These works show that the incidence differs under different conditions, but that its periods of highest prevalence occur during school age and in the first part of military life. The figures for the latter period being particularly important, I have attempted to check them by studying the position in Sweden.

In this country the chances of getting mumps are also highest during school age and military service. The risk of getting the disease during or after adolescence is greater for rural boys than for city boys. In this respect, therefore, my results bear out earlier authors'.

1. Apparently an attack of mumps does not always bring about complete immunity against the virus of the disease. The risk for adults on military service of getting mumps is about 8 times as high for those who say they have not had the disease than for those who believe they have had it. This finding has practical implications since mumps is an important military disease which is responsible for 5–10 per cent of all training and service time lost because of disease by the conscripted personnel in the Swedish Army.

In view of the fact that mumps orchitis gives rise to testicular dysfunction, I have made a special study of the frequency and after-effects of orchitis. The frequency of orchitis in my series is about 20 per cent. About 10 per cent of those who get orchitis have the bilateral form, i.e. about 2 per cent of those who get mumps when they are grown up contract bilateral orchitis. These figures agree rather well with other authors' findings.

Among the consequences of mumps orchitis the effect on the spermiogenesis is well known. In some of my series I was in a position to perform sperm assays. The results obtained, namely that a large number of those who have undergone bilateral mumps orchitis have aspermia or severe oligospermia, agree well with earlier findings by other authors.

The literature is sparing and the data seems inaccurate with regard to the frequency of testicular atrophy, fertility statistics, endocrine imbalance, and repercussions on sexuality following

mumps orchitis. I have been able to contribute to the knowledge regarding the below items which hitherto seem not to have been fully understood:

2. I have developed a method of determining the volume of the testicles. Its error of method may be expressed as follows: The probability that the true value for the volume will deviate at least 25 per cent from the calculated value is 1/3, and that it will deviate at least 50 per cent is 1/20.

Calculated according to my method, the total volume of both testicles in men with two normal testes is about 40 ml. The lower limit for normal testicular volume lies at 20 ml.

As a rule the right testicle is somewhat larger than the left. The difference is statistically significant and amounts to about 2 ml.

In 76 men who had undergone bilateral mumps orchitis the total mean volume was about 25 ml. The total mean testicular volume in men who had undergone bilateral mumps orchitis, thus, averaged 15 ml less than in "normal" men. The difference is statistically significant.

In my view the available material warrants the statements that a total testicular volume under 20 ml is equivalent to bilateral atrophy of the testicles, and that a difference between the testicles of 10 ml indicates unilateral testicular atrophy.

Testicular atrophy following mumps orchitis occurs in 65 per cent, bilateral in 40 per cent and unilateral in about 25 per cent.

3. In order to assess the effects following mumps orchitis on the marriage rate, I have studied the latter in 98 men who had undergone bilateral mumps orchitis and in as many controls. Among the former 30.6 $\pm$ 4.7 were single, whereas among the latter 13.3 $\pm$3.4 per cent were single. The difference is 17.3 $\pm$ 5.8 per cent. Thus, compared to "normals," men who have undergone bilateral mumps orchitis show a lower marriage rate, the difference being statistically significant.

4. The same groups of persons were used to determine the reproductivity reduction, if any, following mumps orchitis. Among those who had undergone bilateral mumps orchitis 48 per cent were fertile, and so were 83 per cent of the controls. The difference is statistically significant. Hence, fertility is reduced by about 1/3 (35 %) following mumps orchitis.

Among those who had married, 67 per cent of the mumps orchitis group and 94 per cent of the controls were fertile. The difference is

statistically significant. Thus, following bilateral mumps orchitis the fertility of married men is reduced by about 1/4 (26.5 %).

Married men who had undergone mumps orchitis had the same average number of children as the controls.

5. The excretion of gonadotropic hormone was assayed in 47 men who hade undergone bilateral mumps orchitis and 10 controls. the excretion of active urinary androgens in, respectively, 59 and 25, and the excretion of 17-ketosteroids in, respectively, 60 and 25.

The excretion of gonadotropic hormone was less than 30 m.u.u. per 24 hours in all the controls and 19 orchitics. 11 orchitics excreted between 30 and 60 m.u.u. per 24 hours. In 17 orchitics, i.e. about one third of the cases, the excretion of gonadotropic hormone was increased, in 4 cases it was very high (more than 120 m.u.u. per 20 hours).

Compared to the normal groups of other authors. both my normals and the orchitics showed low excretion levels for active urinary androgens. The available data warrant no conclusions concerning the decrease, if there is one, in the excretion of active androgens following mumps orchitis.

For all the assayed persons the mean 17-ketosteroid excretion was 9.9 mg per 24 hours. There was no difference between those who had undergone mumps orchitis and the controls.

Thus, bilateral mumps orchitis seems to damage the testicles. probably the tubules, so severely that the secretion of pituitary gonadotropic hormone is affected. A large number of the men who have bilateral mumps orchitis when they are grown up the disease consequently gives rise to a serious endocrine imbalance.

6. I have investigated whether bilateral mumps orchitis is followed by any changes in physique by comparing some anthropological measurements from the mumps orchitis group. the controls of the same age and available data from a large group of normals. No appreciable difference could be found between the means for these groups. Nor was there any marked change in the accessory sex organs. Three cases of suspected eunuchoidism following mumps orchitis are described, though none of them can definitely be defined as eunuchoidism.

7. The sexuality was charted in the mumps orchitis patients and their controls and in a normal series of young conscripts. The mean age for first coitus is lower in the young conscripts than in the middle-aged men. The mean age for the mumps orchitics was 19 years and

for their controls 20.4 years at first coitus. The material is too small to warrant conclusions whether the difference is due to random variation, which seems most probable, or indicates that men who have coitus early are more susceptible to orchitis if they are infected with mumps when they are grown up. The investigation reveals that the libido possibly is slightly lower in those who have had mumps orchitis than in their controls of the same age, when 20—30 years have elapsed after the disease, but the material is far too small and the basis for the breakdown much too fluid to warrant definite conclusions. The figures likewise suggest that the coitus frequency is somewhat lower in the orchities than in the controls. I was unable to find any correlation between testicular volume and libido or coitus frequency.

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